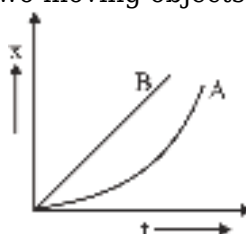


PHYSICS

1) Suppose we employ a system in which the unit of mass equals 100 kg, the unit of length equals 1 km and the unit of time 100 sec and call the unit of energy as eluoj (joule written in reverse order), then what is the relation between eluoj and joule?

- (1) 1 eluoj = 10^4 joule
- (2) 1 joule = 10^4 eluoj
- (3) 1 eluoj = 10^3 joule
- (4) 1 joule = 10^3 eluoj

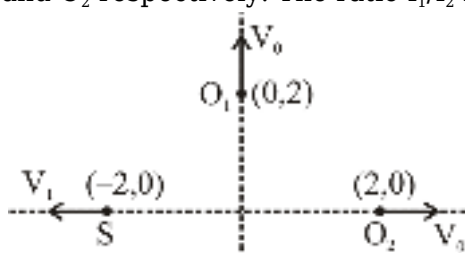
2) The displacement-time graph of two moving objects A and B are shown in the figure given below.



Which of the following is incorrect ?

- (1) B is moving with constant velocity
- (2) A is moving with increasing speed
- (3) B is moving with non-zero constant acceleration
- (4) Acceleration of A may be constant

3) At $t = 0$ a sound source S and observers O_1 & O_2 are placed as shown. S is moving with speed V_1 and O_1 and O_2 are moving with speed V_0 . At any later instant, let f_1 and f_2 represent apparent frequencies of sound observed by O_1 and O_2 respectively. The ratio f_1/f_2 is (Note : V_1 and V_0 are less than speed of sound in this medium.)



- (1) zero
- (2) 1
- (3) between 0 and 1
- (4) greater than 1

4) Consider a uniform electric field $\vec{E} = 3 \times 10^3 \hat{i}$ N/C. What is the flux of this field through a square of 10 cm side length and normal to the plane makes α , β , γ from x-axis, y-axis and z-axis and $\sin \alpha =$

$$\frac{\sqrt{3}}{2}, \sin\beta = \frac{\sqrt{3}}{2}, \sin\gamma = \frac{1}{\sqrt{2}} :-$$

(1) $30 \frac{\text{Nm}^2}{\text{C}}$

(2) $15 \frac{\text{Nm}^2}{\text{C}}$

(3) $\frac{45}{2} \frac{\text{Nm}^2}{\text{C}}$

(4) $20 \frac{\text{Nm}^2}{\text{C}}$

5)

A flag is mounted on a car moving due North with velocity of 20 km/hr. Strong winds are blowing due East with velocity of 20 km/hr. The flag will point in direction

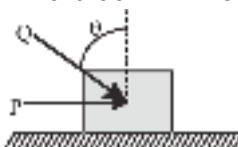
(1) East

(2) North-East

(3) South-East

(4) South-West

6) A block of mass m lying on a rough horizontal plane is acted upon by a horizontal force P and another force Q inclined at an angle θ to the vertical. The block will remain in equilibrium if the



coefficient of friction between it and the surface is :-

(1) $\frac{P + Q \sin \theta}{mg + Q \cos \theta}$

(2) $\frac{P \cos \theta + Q}{mg - Q \sin \theta}$

(3) $\frac{P + Q \cos \theta}{mg + Q \sin \theta}$

(4) $\frac{P \sin \theta - Q}{mg - Q \cos \theta}$

7) A sonometer string vibrates in 3rd overtone. If distance between bridges is 40 cm, tension in the string is 90 N and mass/length of string is 100 gm/m, what is the frequency ?

(1) 475 Hz

(2) 112.5 Hz

(3) 37.5 Hz

(4) 75 Hz

8) A body of mass 5 kg is suspended by string making angle 60° & 30° with horizontal then -



(a) $T_1 = 25 \text{ N}$

(b) $T_2 = 25 \text{ N}$

(c) $T_1 = 25\sqrt{3} \text{ N}$

(d) $T_2 = 25\sqrt{3} \text{ N}$

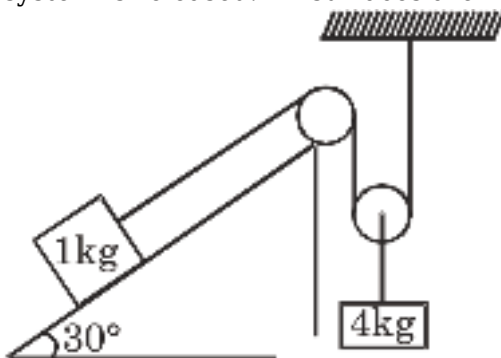
(1) a, b

(2) a, d

(3) c, d

(4) b, c

9) Find the work done by tension on 1 kg block when the 4kg block moves down by 1m after the system is released. All surfaces are frictionless & strings are ideal :- ($g = 10 \text{ m/s}^2$)



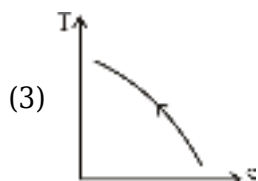
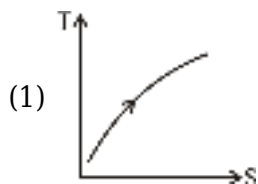
(1) 25 J

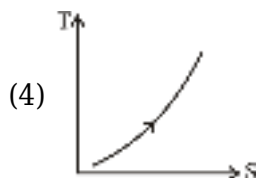
(2) 50 J

(3) 100 J

(4) None of these

10) An ideal gas undergoes isobaric expansion. Graph between temperature of gas and entropy is :-

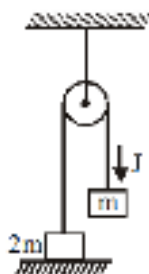




11) A man can swim in still water with velocity of 4 m/s and river is flowing with velocity of 3m/s. If width of river is 60 m then minimum time required to cross the river will be :-

- (1) 12 s
- (2) 15 s
- (3) 20 s
- (4) 30 s

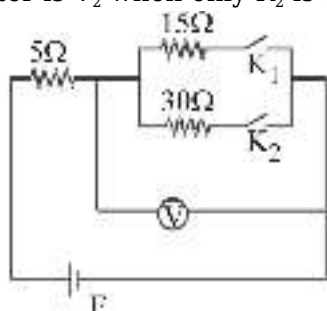
12) In the given figure an impulse J is given to the block of mass m in the downward direction. As a



result of the impulse :-

- (1) Both the blocks start moving with speed $\frac{J}{3m}$
- (2) Both the blocks start moving with speed $\frac{J}{m}$ in opposite direction
- (3) The centre of mass of the system is moving downwards
- (4) The centre of mass of the system is not moving

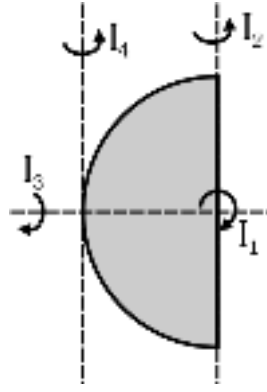
13) In the circuit shown in figure reading of voltmeter is V_1 when only K_1 is closed, reading of voltmeter is V_2 when only K_2 is closed and reading of voltmeter is V_3 when both K_1 and K_2 are closed.



Then :-

- (1) $V_3 > V_2 > V_1$
- (2) $V_2 > V_1 > V_3$
- (3) $V_3 > V_1 > V_2$
- (4) $V_1 > V_2 > V_3$

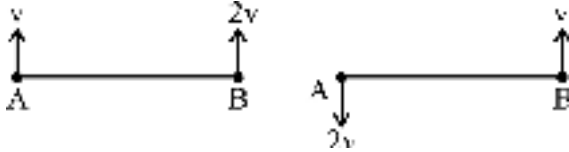
14) Moment of inertia of a uniform hollow hemisphere of mass m and radius r about various axes are



indicated in the figure. Which of the following is correct?

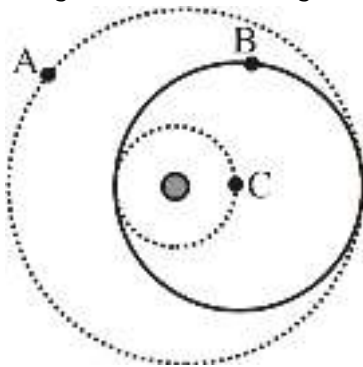
- (1) $I_1 + I_2 = I_3$
- (2) $I_2 + I_3 = I_1$
- (3) $I_3 + I_4 = I_1$
- (4) $I_1 + I_2 = 2I_4$

15) A rod AB is a uniform rod. The end points on the rod are given velocities in two cases as shown. Find the ratio of distance of instantaneous axis of rotation from A in both the cases :-



- (1) 2 : 3
- (2) 2 : 1
- (3) 1 : 1
- (4) 3 : 2

16) Three equal mass satellites A, B, and C are in coplanar orbits around a planet as shown in the figure. The magnitudes of the angular momenta of the satellites as measured about the planet are L_A



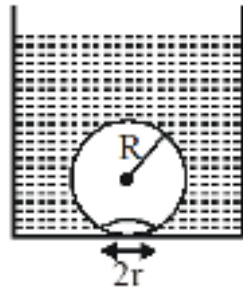
L_B , and L_C .

- (1) $L_A > L_B > L_C$
- (2) $L_C > L_B > L_A$
- (3) $L_B > L_C > L_A$
- (4) $L_B > L_A > L_C$

17) Surface tension $\left(S = \frac{\text{Force}}{\text{length}} \right)$ is the property of a liquid surface. If dimension formula is $S = M^x L^y T^z$ then the value of $x - z + y$ is :-

- (1) 0
- (2) 1
- (3) 2
- (4) 3

18) On heating water, bubbles being formed at the bottom of the vessel detach and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of the vessel. If $r \ll R$, and the surface tension of water is T , value of r just before bubbles detach is



(density of water is ρ_w)

- (1) $R^2 \sqrt{\frac{\rho_w g}{T}}$
- (2) $R^2 \sqrt{\frac{3\rho_w g}{T}}$
- (3) $R^2 \sqrt{\frac{2\rho_w g}{3T}}$
- (4) $R^2 \sqrt{\frac{\rho_w g}{6T}}$

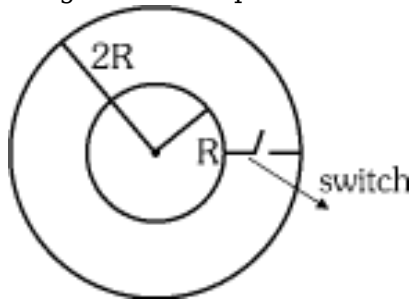
19) Two particles perform simple harmonic motion of same frequency and about same mean position. Their amplitude is same and is equal to A and their time period is T . If at $t = 0$ their separation is maximum and is A , their separation at $t = \frac{T}{12}$ is :

- (1) $A \frac{\sqrt{3}}{2}$
- (2) A
- (3) $\frac{A}{\sqrt{2}}$
- (4) $\frac{A}{2}$

20) Which of the following can be a set of fundamental quantities

- (1) length, velocity, time
- (2) momentum, mass, velocity
- (3) force, mass, velocity
- (4) momentum, time, frequency

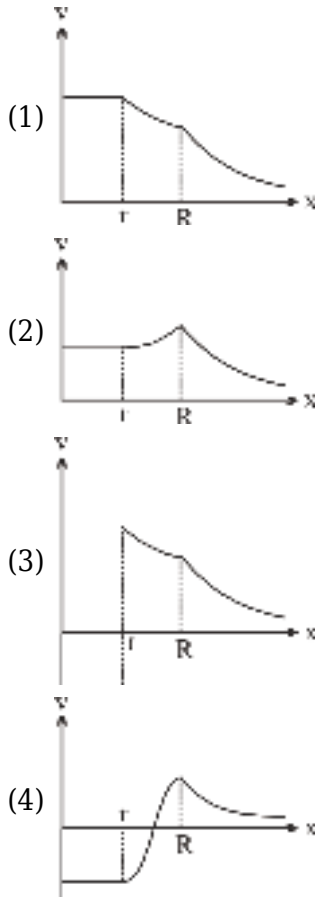
21) Net positive charge on inner spherical conductor is $3Q$ and on outer spherical conductor is Q .



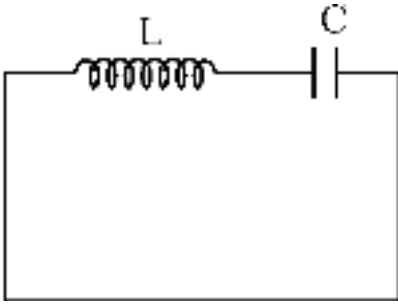
Switch is closed.

- (1) Charge will flow from inner shell to outer shell
- (2) Charge will flow from outer shell to inner shell
- (3) Charge will not flow
- (4) none of these

22) Two concentric spherical shells of radii r and R ($r < R$) have surface charge densities $-\sigma$ and $+\sigma$ respectively. The variation of electric potential V with distance x from the centre O of the shells plotted. Which of the following graphs best depict the variation qualitatively?



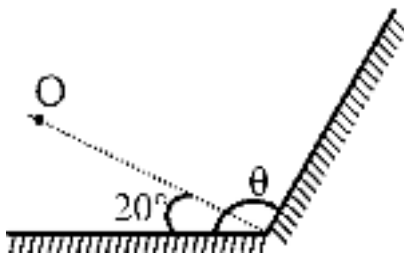
23) In an LC circuit the capacitor has maximum charge q^0 . The value of $\left(\frac{dI}{dt}\right)_{\max}$ is :-



- (1) $\frac{q_0}{LC}$
- (2) $\frac{q_0}{\sqrt{LC}}$
- (3) $\frac{q_0}{2LC}$
- (4) $\frac{2q_0}{LC}$

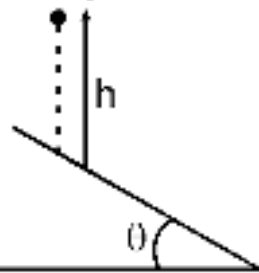
24)

If $\theta = 110^\circ$ then total number of images formed by the mirror system will be :-



- (1) 2
- (2) 3
- (3) 4
- (4) 5

25) A ball of mass m strikes the fixed inclined plane after falling through a height h . If it rebounds

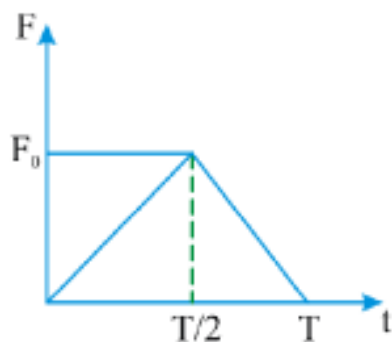


elastically, the impulse on the ball is :

- (1) $2 m \cos \theta \sqrt{2gh}$
- (2) $2 m \cos \theta \sqrt{gh}$
- (3) $\frac{2m\sqrt{2gh}}{\cos \theta}$
- (4) $2m\sqrt{2gh}$

26) A particle of mass m moving with velocity u makes an elastic one-dimensional collision with a

stationary particle of mass m . They are in contact for a very brief time T . Their force of interaction increases from zero to F^0 linearly in time $\frac{1}{2}T$. The magnitude of F^0 is

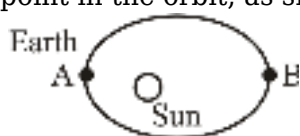


- (1) $\frac{mu}{T}$
- (2) $\frac{2mu}{T}$
- (3) $\frac{mu}{2T}$
- (4) $\frac{3mu}{2T}$

27) A Bohr's theory student claims that he has observed a spectral line of wavelength 244 nm from a sample of hydrogen gas. This line belongs to :-

- (1) Lyman series
- (2) Balmer series
- (3) Paschen series
- (4) Hydrogen gas cannot emit this wavelength

28) The earth is moving around the sun in an elliptical orbit. Point A is the closest and point B is the farthest point in the orbit, as shown. In comparison to the situation when the earth passes through



point B :

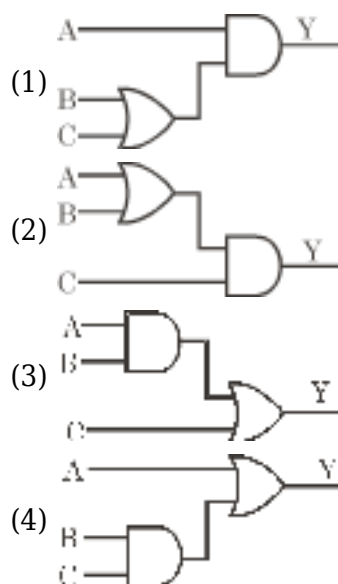
- (1) total energy of the earth-sun system is greater when the earth passes through point A.
- (2) gravitational potential energy of the earth-sun system is greater when the earth passes through point A.
- (3) kinetic energy of the earth due to the motion around the sun is greater when it passes through the point A.
- (4) magnitude of angular momentum of the earth about the sun is greater when the earth passes through point A.

29) In a digital circuit for three input signals (A, B and C) the final output (Y) should be such that for

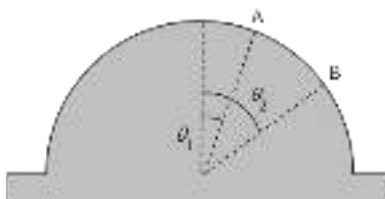
A	B	C
0	0	0
0	0	1

inputs 0 1 0 the output (Y) should be 0 and for all other cases it should be 1. Which of the

following digital circuits will give such output ?



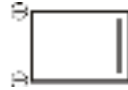
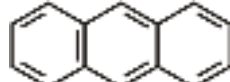
30) A small block slides down from rest at point A on the surface of a smooth circular cylinder, as shown. At point B, the block falls off (leaves) the cylinder. The equation relating the angles θ_1 and θ_2 is given by



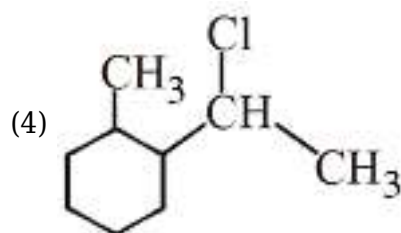
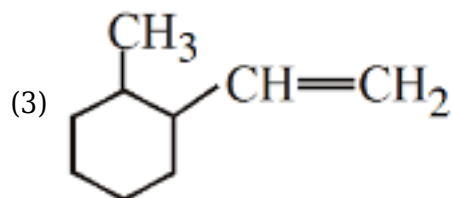
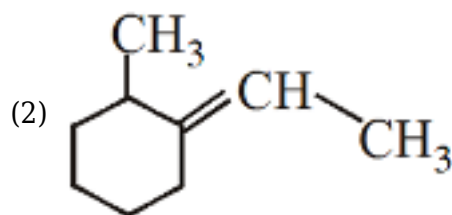
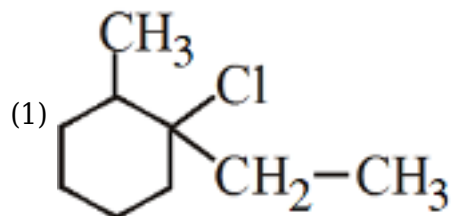
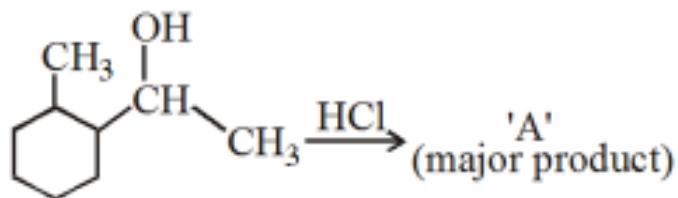
- (1) $\sin \theta_2 = \frac{2}{3} \sin \theta_1$
- (2) $\sin \theta_2 = \frac{3}{2} \sin \theta_1$
- (3) $\cos \theta_2 = \frac{2}{3} \cos \theta_1$
- (4) $\cos \theta_2 = \frac{3}{2} \cos \theta_1$

CHEMISTRY

1) Which one of the following compounds is non-aromatic ?

- (1) 
- (2) 
- (3) 
- (4) 

2) What is the final product (major) 'A' in the given reaction ?



3) Match List I with List II.

List I (Monomer Unit)		List II (Polymer)	
(a)	Caprolactum	(i)	Natural rubber
(b)	2-Chloro-1,3-butadiene	(ii)	Buna-N
(c)	Isoprene	(iii)	Nylon 6
(d)	Acrylonitrile	(iv)	Neoprene

Choose the correct answer from the options given below :

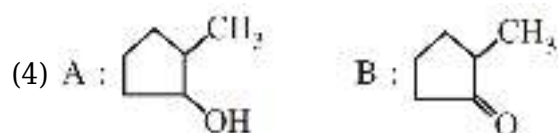
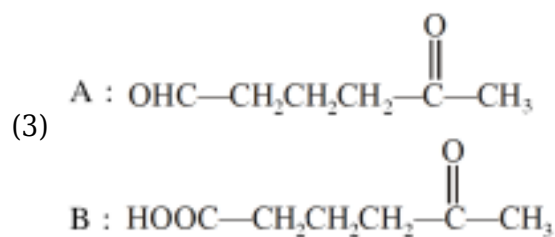
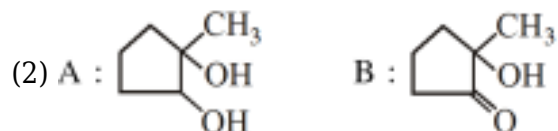
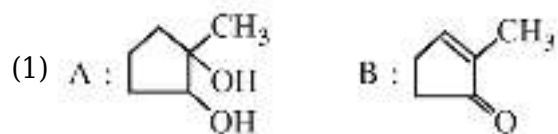
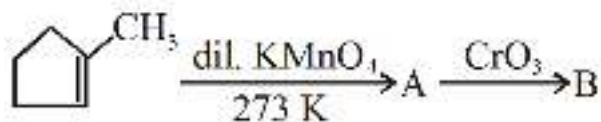
(1) (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)

(2) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)

(3) (a) → (iii), (b) → (iv), (c) → (i), (d) → (ii)

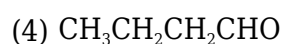
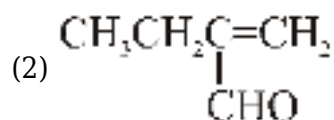
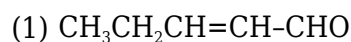
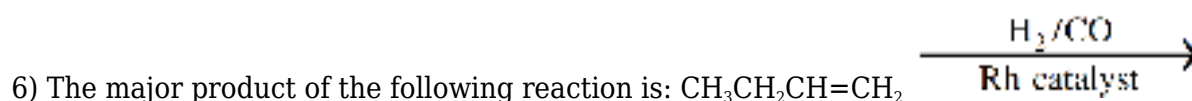
(4) (a) → (i), (b) → (ii), (c) → (iii), (d) → (iv)

4) Identify products A and B :



5) The gas released during anaerobic degradation of vegetation may lead to :

- (1) Ozone hole
- (2) Acid rain
- (3) Corrosion of metals
- (4) Global warming and cancer



7) Which of the glycosidic linkage between galactose and glucose is present in lactose?

- (1) C-1 of galactose and C-4 of glucose
- (2) C-1 of glucose and C-6 of galactose
- (3) C-1 of glucose and C-4 of galactose
- (4) C-1 of galactose and C-6 of glucose

8) Given below are two statements :

Statement I : A mixture of chloroform and aniline can be separated by simple distillation.

Statement II : When separating aniline from a mixture of aniline and water by steam distillation aniline boils below its boiling point.

In the light of the above statements, choose the most appropriate answer from the options given below.

- (1) Statement-I is false but Statement II is true
- (2) Both Statement-I and Statement II are false
- (3) Statement-I is true but Statement II is false
- (4) Both Statement-I and Statement II are true

9) Ceric ammonium nitrate and CHCl_3 / alc. KOH are used for the identification of functional groups present in _____ and _____ respectively.

- (1) Alcohol, phenol
- (2) Amine, alcohol
- (3) Alcohol, amine
- (4) Amine, phenol

10) In $\overset{1}{\text{CH}_2} = \overset{2}{\text{C}} = \overset{3}{\text{C}}\text{H} - \overset{4}{\text{C}}\text{H}_3$ molecule, the hybridization of carbon 1, 2, 3 and 4 respectively are :

- (1) sp^3 , sp , sp^3 , sp^3
- (2) sp^2 , sp^2 , sp^2 , sp^3
- (3) sp^2 , sp , sp^2 , sp^3
- (4) sp^2 , sp^3 , sp^2 , sp^3

11) Molality of pure liquid benzene if its density is 1.23 gm/ml is -
(Molar Mass of benzene = 78 gm)

- (1) 15.77 m
- (2) 5 m
- (3) 1.577 m
- (4) 12.8 m

12) In hydrogen atom, two electrons move around the nucleus in circular orbits of radii R and 4R. Find the ratio of the time taken by them to complete one revolution ? (Considering Bohr's atomic theory is applicable)

- (1) 1 : 4
- (2) 4 : 1
- (3) 1 : 8
- (4) 8 : 1

13) The equilibrium concentration of B $[(\text{B})_e]$ for the reversible reaction $\text{A} \rightleftharpoons \text{B}$ can be evaluated by the expression:-

- (1) $\frac{K_c}{[A]_e^{-1}}$
- (2) $\frac{k_f}{k_b} [A]_e^{-1}$
- (3) $k_f k_b^{-1} [A]_e$
- (4) $k_f k_b [A]^{-1}$

14) A Schottky defect may involve all but one of the following. Which one is incorrect ?

- (1) A vacant cation and a vacant anion in an MX lattice.
- (2) Vacant cation : anion sites in ratio 1 : 2 in an MX_2 lattice.
- (3) Vacant cation : anion sites in ratio 2 : 1 in an M_2X lattice.
- (4) Random vacancy in any lattice.

15)

If osmotic pressure of Na_2CO_3 solution is 2 atm. Calculate the degree of dissociation at 127° . If concentration of Na_2CO_3 is 0.02 mol/L.

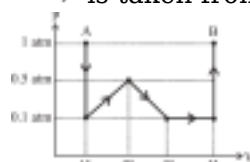
- (1) 100%
- (2) 50%
- (3) 25%
- (4) 75%

16) The rate of a reaction quadruples when the temperature changes from 300 to 310 K. The activation energy of this reaction is:

(Assume activation energy and pre-exponential factor are independent of temperature; $\ln 2 = 0.693$; $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$)

- (1) $107.2 \text{ kJ mol}^{-1}$
- (2) 53.6 kJ mol^{-1}
- (3) $214.4 \text{ kJ mol}^{-1}$
- (4) 26.8 kJ mol^{-1}

17) An ideal gas having $\left(\gamma = \frac{4}{3}\right)$ is taken from A to B according to given diagram, calculate ΔH for



ideal gas in process A to B.

- (1) 25.6 atm-L
- (2) 48 atm-L
- (3) 12 atm-L
- (4) 19 atm-L

18) Acetic acid, CH_3COOH can form a dimer $(\text{CH}_3\text{COOH})_2$ in the gas phase $2\text{CH}_3\text{COOH}(\text{g}) \rightleftharpoons (\text{CH}_3\text{COOH})_2(\text{g})$; $\Delta H_{298\text{K}} = -66.5 \text{ kJ}$ if at 25°C , the equilibrium constant for this reaction is 10^3 then calculate ΔS° for this reaction :-

- (1) $-0.563 \text{ kJ mol}^{-1} \text{ K}^{-1}$
- (2) $-0.763 \text{ kJ mol}^{-1} \text{ K}^{-1}$
- (3) $+0.563 \text{ kJ mol}^{-1} \text{ K}^{-1}$
- (4) $-0.165 \text{ kJ mol}^{-1} \text{ K}^{-1}$

19) A weak acid HX ($K_a = 10^{-5}$) forms a salt NaX when reacted with NaOH . What is % hydrolysis of 0.1 M NaX aqueous solution :

- (1) 0.0001%
- (2) 0.001%
- (3) 0.01%
- (4) 0.1%

20) The ionization constant of a weak monobasic acid is 25×10^{-6} while the equivalent conductance of its 0.01 M solution is $19.6 \text{ S cm}^2 \text{ eq}^{-1}$. The equivalent conductance of the electrolyte at infinite dilution (in $\text{S cm}^2 \text{ eq}^{-1}$) will be

- (1) 250
- (2) 196
- (3) 392
- (4) 384

21) Which order is wrong :-

- (1) Electronegativity - $\text{P} < \text{N} < \text{O} < \text{F}$
- (2) 1st ionisation energy - $\text{B} < \text{Be} < \text{O} < \text{N}$
- (3) Basic nature - $\text{MgO} > \text{CaO} > \text{FeO} > \text{Fe}_2\text{O}_3$
- (4) First electron affinity - $\text{S} < \text{Se} < \text{Te} < \text{O}$

22) Which of the following statement is correct for BrF_5 :

- (1) Total number of lone pairs present is 15
- (2) Maximum number of atoms in one plane = 5
- (3) Molecule is polar
- (4) Bromine has its maximum covalency in this molecule

23)

Select the **CORRECT** statements?

- (i) $[\text{Zn}(\text{gly})_2]$ is optically active compound
- (ii) $[\text{PdClBr}(\text{gly})]^-$ exhibits geometrical isomerism
- (iii) $[\text{IrBr}_4(\text{en})]^-$ exhibits cis trans isomerism
- (iv) $[\text{RhCl}_2(\text{NH}_3)_4]^+$ number of stereo isomers is equal to number of geometrical isomers

- (1) (i), (ii), (iv)
- (2) (ii), (iii), (iv)
- (3) (ii), (iii)
- (4) (i), (iii), (iv)

24) Which of the following species can act as oxidising agent?

- (1) $[\text{Ni}(\text{CO})_4]$
- (2) $[\text{Fe}(\text{CO})_5]$
- (3) $[\text{Mn}(\text{CO})_6]$
- (4) $[\text{V}(\text{CO})_6]$

25) Which of the following is **NOT** correctly matched

	Method	Used for refining
(1)	Van Arkel	Zr & Ti
(2)	Zone refining	Ge, Si
(3)	Liquation	Zn & Hg
(4)	Mond's process	Ni

- (1) 1
- (2) 2
- (3) 3
- (4) 4

26) Basic radicals which does not give metal sulphide precipitate with dilute $\text{HCl} + \text{H}_2\text{S}$

- (1) Pb^{+2}
- (2) Zn^{+2}
- (3) Cu^{+2}
- (4) Hg^{+2}

27) When Na_2O_2 react with SO_2 then which of the following compound is finally formed -

- (1) $\text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$
- (2) Na_2SO_4
- (3) Na_2SO_3
- (4) $\text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$

28) Which of the following reactions is not associated with Solvay process for the manufacturing of sodium carbonate :

- (1) $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$
- (2) $\text{NH}_3 + \text{H}_2\text{CO}_3 \rightarrow \text{NH}_4\text{HCO}_3$
- (3) $\text{NaCl} + \text{NH}_4\text{HCO}_3 \rightarrow \text{NaHCO}_3$
- (4) $2\text{NaOH} + \text{CO}_2 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$

29) Which of the following aquated ion is having observed magnetic moment = 4.4 - 5.2 (BM)

- (1) Fe^{2+}
- (2) Mn^{2+}
- (3) Co^{2+}
- (4) Ni^{2+}

30) The pH of acid rain water is :

- (1) 1.2
- (2) 3.1
- (3) 5.6
- (4) 6

ENGLISH PROFICIENCY

1) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Despite having ___ evidence, the committee hesitated to reach a conclusion.

- (1) few
- (2) little
- (3) a few
- (4) a little

2) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

The professor insisted that every assignment be submitted _____ the end of the week.

- (1) by
- (2) at
- (3) on
- (4) within

3) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Among all the proposals presented, hers was the _____ and was approved immediately.

- (1) more innovative
- (2) most innovating
- (3) most innovative
- (4) more innovating

4) Choose the odd word from the list :

- (1) Conspicuous

- (2) Noticeable
- (3) Evident
- (4) Obscure

5) Select the option that can be used as a one word substitute for the given group of words :
A person who pretends to have moral standards he does not actually possess, is called a :

- (1) Cynic
- (2) Hypocrite
- (3) Egoist
- (4) Stoic

6) Select the correct pair of homophones to complete the sentence:
The teacher asked the students tothe poem aloud so that itsbecomes clear.

- (1) recite-moral
- (2) resight-morale
- (3) recite-morale
- (4) re-site-moral

7) **Directions :** Read the follow carefully and answer the questions that follow:

In recent years, cities across the world have begun prioritizing sustainability as a guiding principle for urban planning. This shift is driven not only by environmental concerns but also by the recognition that sustainable infrastructure enhances the quality of life for residents. However, achieving long-term sustainability requires more than technological solutions; it demands active public participation and a willingness to adopt new habits. Without collective effort, even the most advanced planning strategies are likely to fall short of their goals.

According to the passage, what is essential for achieving long-term sustainability in cities?

- (1) Rapid technological advancement
- (2) Increased government spending
- (3) Active involvement of citizens
- (4) Expansion of urban infrastructure

8) **Directions :** Read the follow carefully and answer the questions that follow:

In recent years, cities across the world have begun prioritizing sustainability as a guiding principle for urban planning. This shift is driven not only by environmental concerns but also by the recognition that sustainable infrastructure enhances the quality of life for residents. However, achieving long-term sustainability requires more than technological solutions; it demands active public participation and a willingness to adopt new habits. Without collective effort, even the most advanced planning strategies are likely to fall short of their goals.

What does the word “**prioritizing**” most nearly mean as used in the passage?

- (1) Disregarding
- (2) Considering less important
- (3) Giving primary importance to
- (4) Rejecting completely

9) **Directions :** Read the follow carefully and answer the questions that follow:

In recent years, cities across the world have begun prioritizing sustainability as a guiding principle for urban planning. This shift is driven not only by environmental concerns but also by the recognition that sustainable infrastructure enhances the quality of life for residents. However, achieving long-term sustainability requires more than technological solutions; it demands active public participation and a willingness to adopt new habits. Without collective effort, even the most advanced planning strategies are likely to fall short of their goals.

In the passage, the phrase “**this shift**” refers to :

- (1) Environmental degradation in cities
- (2) Increased quality of life for residents
- (3) Global urbanization trends
- (4) Adoption of sustainability as a planning principle

10) **Directions :** Read the follow carefully and answer the questions that follow:

In recent years, cities across the world have begun prioritizing sustainability as a guiding principle for urban planning. This shift is driven not only by environmental concerns but also by the recognition that sustainable infrastructure enhances the quality of life for residents. However, achieving long-term sustainability requires more than technological solutions; it demands active public participation and a willingness to adopt new habits. Without collective effort, even the most advanced planning strategies are likely to fall short of their goals. Which of the following best summarizes the main idea of the passage?

- (1) Cities must invest heavily in technology to achieve sustainability.
- (2) Sustainability in cities depends on both innovative planning and public cooperation.
- (3) Urban sustainability efforts have failed due to lack of funding.
- (4) Citizens must follow government regulations without question.

LOGICAL REASONING

1) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

Flying : Bird :: Creeping : ?

- (1) Aeroplane
- (2) Snail
- (3) Ground
- (4) Flower

2) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

Clock : Time :: Thermometer : ?

- (1) Heat
- (2) Radiation

- (3) Energy
- (4) Temperature

3) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) Jupiter
- (2) Saturn
- (3) Venus
- (4) Sun

4) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) JUDGE
- (2) SCANT
- (3) CROWD
- (4) FLUSH

5) What is the next number in this sequence ?
1, 3, 8, 19, 42, 89, ?

- (1) 108
- (2) 184
- (3) 167
- (4) 97

6) Which is the number that comes next in this sequence ?
5, 16, 51, 158,

- (1) 1452
- (2) 483
- (3) 481
- (4) 1454

7) **Direction :** In the following question, one term in the number series is wrong. Find out the wrong term.

15, 16, 22, 29, 45, 70

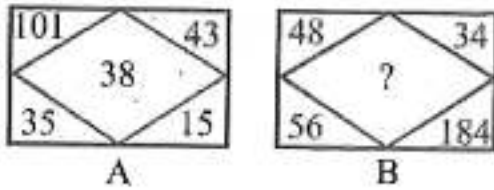
- (1) 16
- (2) 22
- (3) 45
- (4) 70

8) The diagram below is a 'magic square' in which all rows and columns and both diagonals add up to 34. Find xy

1	8	13	12
14			
4	x	16	y
15			

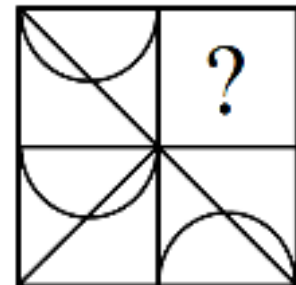
- (1) 77
- (2) 60
- (3) 45
- (4) 63

9) Find the missing number :



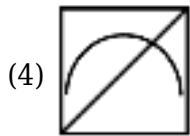
- (1) 127
- (2) 142
- (3) 158
- (4) 198

10) **Direction :** In each of the following questions, a part of the figure is missing. Find out from the

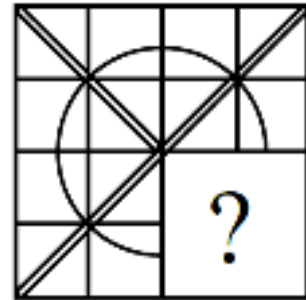


given options (1, 2, 3 and 4) the right figure to fit in the missing place.

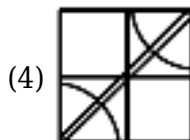
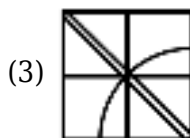
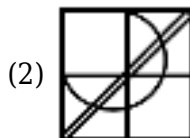
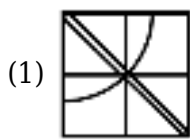
- (1)
- (2)
- (3)



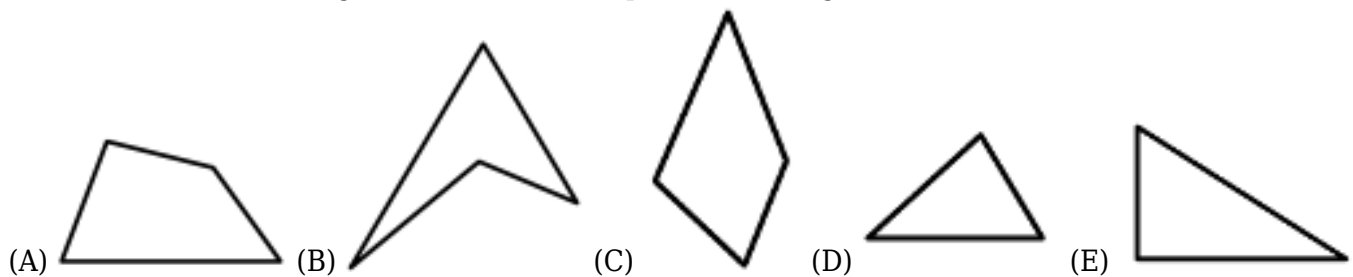
11) **Direction :** In each of the following questions, a part of the figure is missing. Find out from the



given options (1, 2, 3 and 4) the right figure to fit in the missing place.

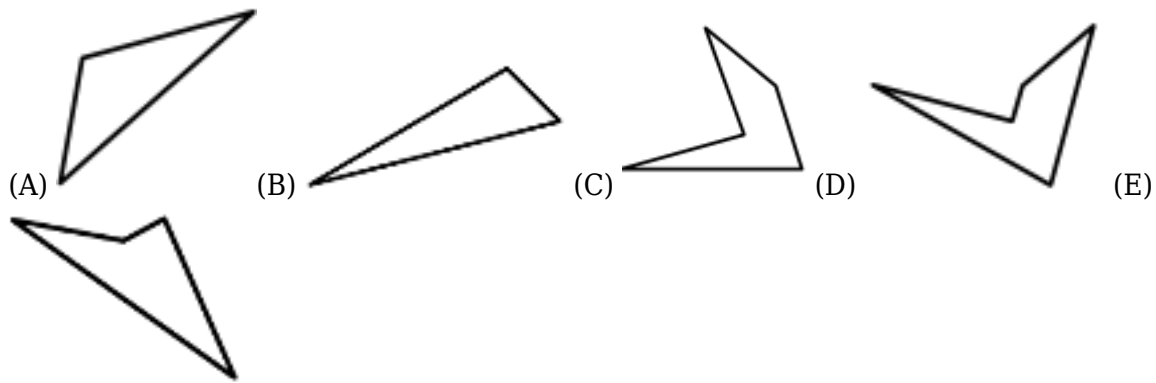


12) **Direction :** In each of the following questions select that combination of parts (A), (B), (C), (D) and (E) which if fitted together will form an equilateral triangle.



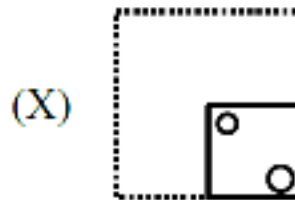
- (1) ABC
- (2) BCD
- (3) ABD
- (4) ABE

13) **Direction :** In each of the following questions select that combination of parts (A), (B), (C), (D) and (E) which if fitted together will form an equilateral triangle.



- (1) ABC
- (2) ACE
- (3) BCD
- (4) BDE

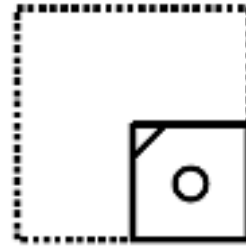
14) **Direction :** If a square sheet of paper is folded two times from the centre and cuts are made as shown in the problem figure how will it appear when it is opened ? Select the appropriate figure



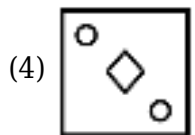
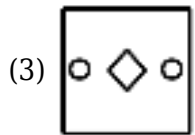
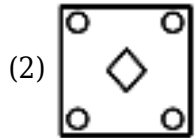
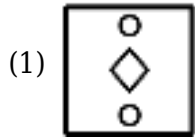
from the answer choices marked (1), (2), (3) and (4).

- (1)
- (2)
- (3)
- (4)

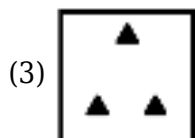
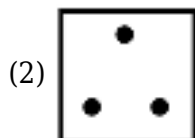
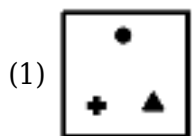
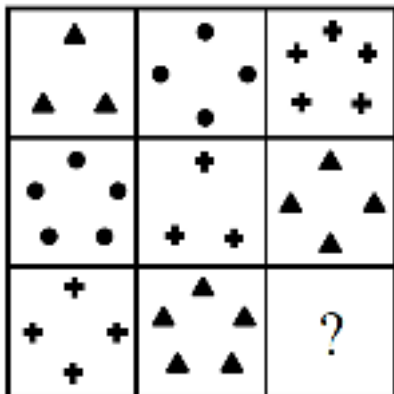
15) **Direction :** If a square sheet of paper is folded two times from the centre and cuts are made as shown in the problem figure how will it appear when it is opened ? Select the appropriate figure

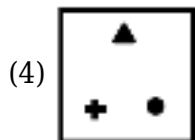


from the answer choices marked (1), (2), (3) and (4).



16) **Direction :** In each of the following questions, select the answer figure that will fit in the blank space in the question figure, maintaining the pattern in the proper sequence.

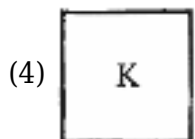
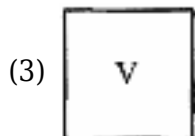
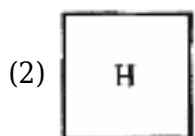
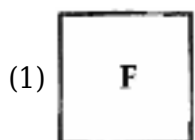




17) **Direction :** In each of the following questions, select the answer figure that will fit in the blank space in the question figure, maintaining the pattern in the proper sequence.

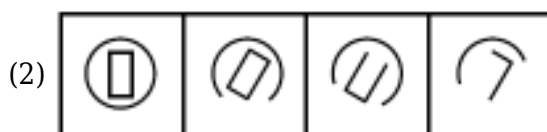
MT	LI	N
IV	T	I
F	I	?

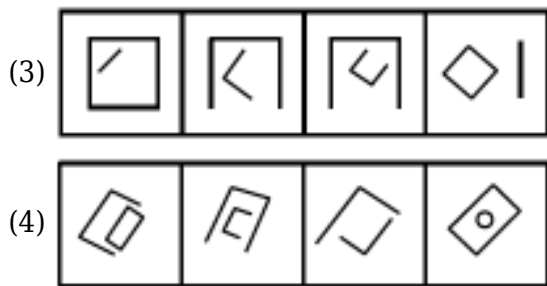
Which of the tiles A to H will fit logically into the missing space?



18) **Direction :** Each of the following questions contains four rows of figures. As four alternatives. Each row contains four of five different designs. You have to study carefully each row and judge which series of figures follows the stated rule exactly.

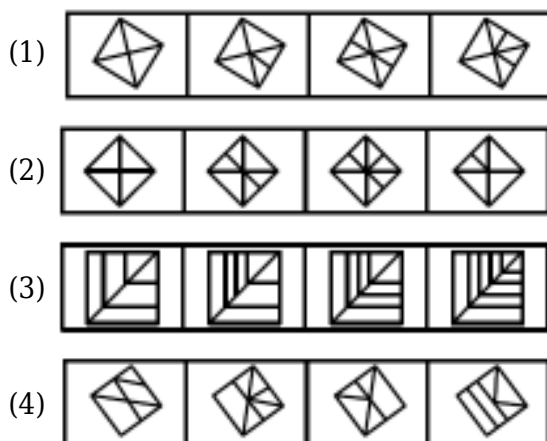
Rule : Closed figures gradually become open, and open figures gradually become closed.





19) **Direction :** Each of the following questions contains four rows of figures. As four alternatives. Each row contains four of five different designs. You have to study carefully each row and judge which series of figures follows the stated rule exactly.

Rule : The simple figures become more complex along a row.



20) **Direction for Question 20 :** Read the following information carefully and then answer the question given below it :

Following are the conditions for allotment of flats built by Town Council in the newly developed area of city Gurgaon. The applicant must.

(A) produce domicile certificate of the State.

(B) be employed or self-employed in Gurgaon for minimum of 5 years.

(C) be ready to pay the entire amount in 5 years period.

(D) not be owner or co-owner (if spouse is owner) of a residential accommodation in the city limit of Gurgaon.

(E) not be less than 35 years of age as on 31st December 1996.

In case of applicant who satisfies all other criteria except :

(I) at A above, be referred to President of Town council.

(II) at B above, but is ready to produce ration card of last five years should be referred to Vice-Chairman of House Allotment Committee.

(III) at C above, but is a freedom fighter or an ex-serviceman or first relation i.e. son / daughter / husband / wife of freedom fighter / ex-serviceman should be referred to Vice-Chairman of House Allotment Committee who can give concession per payment upto 15 years in such cases. The last date for receipt of application was 31st December, 1996. Conditions set out in terms of age or duration of stay are to be fulfilled as on 31st December, 1996. Based on these criteria and information provided below, decide the course of action in each case. You are not to assume anything extra. If the data provided is not adequate to decide the given course of action, your answer will be 'data inadequate'. The cases are given to you as on 1st January 1997.

Maganlal is a 38 years' old senior clerk in a local builder's office in Gurgaon. He has put in service of 13 years but still does not own a house. He has produced domicile certificate and is ready to pay the entire amount in 8 years. He is nephew of freedom fighter Jaganlal who stays in a nearby village.

- (1) Do not allot flat
- (2) Refer to the Vice-Chariman
- (3) Refer to the Chairman
- (4) Allot flat

MATHEMATICS

1)

The volume of a spherical balloon is increasing at the rate of 40 *cubic centrimetre per minute*. The rate of change of the surface of the balloon at the instant when its radius is 8 *centimetre*, is

- (1) 10
- (2) 15
- (3) 18
- (4) 22

2) Difference between the greatest and the least values of the function $f(x) = x(\ln x - 2)$ on $[1, e^2]$ is

- (1) 2
- (2) e
- (3) e^2
- (4) 1

3) The minimum value of $Z = 4x + 3y$ subjected to the constraints $3x + 2y \geq 160$, $5x + 2y \geq 200$, $x + 2y \geq 80$; $x, y \geq 0$ is

- (1) 220
- (2) 300
- (3) 230
- (4) none of these

4) Let

p : Ramesh listens to music.

q : Ramesh is out of his village

r : It is Sunday

s : It is Saturday

Then the statement "Ramesh listens to music only if he is in his village and it is Sunday or Saturday" can be expressed as

- (1) $((\sim q) \wedge (r \vee s)) \Rightarrow p$
- (2) $(q \wedge (r \vee s)) \Rightarrow p$
- (3) $p \Rightarrow (q \wedge (r \vee s))$
- (4) $p \Rightarrow ((\sim q) \wedge (r \vee s))$

5) Number of integers satisfying the equation :-

$$|x^2 + 5x| + |x - x^2| = |6x| \text{ is}$$

- (1) 8
- (2) 7
- (3) 11
- (4) 5

6)

The inequality $\left(\frac{1}{2}\right)^{x^6-2x^4} < 2^{x^2}$ is valid for x belongs to

- (1) R
- (2) $(0, \infty)$
- (3) $(-\infty, -1) \cup (-1, \infty)$
- (4) $(-\infty, -1) \cup (-1, 0) \cup (0, 1) \cup (1, \infty)$

7)

Solution set of $\log_{(x^2)} \left(\frac{x}{|x|} - x \right) \geq 0$ is

- (1) $(-\infty, 0) \cup (1, 2)$
- (2) $(-\infty, 1) \cup (2, \infty)$
- (3) $(-\infty, -1) \cup (0, 1)$
- (4) $(-\infty, -2] \cup (0, 1)$

8) Let $f(n) = \prod_{r=1}^n 2^{r \cdot r!}$, then the value of $\left(\frac{1}{(2016)!} \right) \log_2 (2f(2015))$ is-

- (1) 2017
- (2) 2015
- (3) 1
- (4) $(2015)!$

9)

Sum of common roots of the equation $z^3 + 2z^2 + 2z + 1 = 0$ and $z^{1985} + z^{100} + 1 = 0$ is :-

- (1) 0
- (2) 1
- (3) 2
- (4) -1

10) Coefficient of x^{n-6} in the expansion

$$\frac{n}{n} \left[x - \left(\frac{{}^nC_0 + {}^nC_1}{{}^nC_0} \right) \right] \left[\frac{x}{2} - \left(\frac{{}^nC_1 + {}^nC_2}{{}^nC_1} \right) \right] \left[\frac{x}{3} - \left(\frac{{}^nC_2 + {}^nC_3}{{}^nC_2} \right) \right] \dots \left[\frac{x}{n} - \left(\frac{{}^nC_{n-1} + {}^nC_n}{{}^nC_{n-1}} \right) \right]$$

is equal to

(where $n = n \cdot (n-1) \cdot (n-2) \dots 3 \cdot 2 \cdot 1$)

(1) ${}^nC_6(n+1)^6$

(2) ${}^nC_6 \cdot n^6$

(3) ${}^nC_6(n+2)^6$

(4) ${}^nC_5(n+1)^5$

11) Let S_n denotes the sum of n terms of an A.P. If $S_{2n} = 3S_n$, then $\frac{S_{3n}}{S_n} =$

(1) 4

(2) 6

(3) 8

(4) 10

12) The equation of the lines on which the perpendiculars from the origin make 30° angle with x -axis

and which form a triangle of area $\frac{50}{\sqrt{3}}$ with axes, are

(1) $x + \sqrt{3}y \pm 10 = 0$

(2) $\sqrt{3}x + y \pm 10 = 0$

(3) $x \pm \sqrt{3}y - 10 = 0$

(4) None of these

13) The normal at the point (3, 4) on a circle cuts the circle again at the point (1, 2). Then the equation of the circle is -

(1) $x^2 + y^2 - 4x - 6y + 12 = 0$

(2) $x^2 + y^2 - 4x + 6y - 12 = 0$

(3) $x^2 + y^2 - 4x - 6y + 11 = 0$

(4) $x^2 + y^2 - 4x + 6y + 11 = 0$

14) The triangle formed by the tangent to the parabola $y = x^2$ at the point whose abscissa is x_0 , where $x_0 \in [1, 2]$, the y -axis and the straight line $y = x_0^2$ has the greatest area if x_0 is equal to :

(1) 0

(2) 1

(3) 2

(4) 3

15) Let $E_2 : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ $a > b$. Let E_2 be another ellipse such that it touches the end points of major axis of E_1 and the foci of E_2 are the end points of minor axis of E_1 . If E_1 and E_2 have same eccentricities, then its value is :

(1) $\frac{-1 + \sqrt{5}}{2}$

(2) $\frac{-1 + \sqrt{8}}{2}$

(3) $\frac{-1 + \sqrt{3}}{2}$

(4) $\frac{-1 + \sqrt{6}}{2}$

16) If the locus of the foot of perpendicular from the centre upon any normal to the hyperbola $\frac{x^2}{1} - \frac{y^2}{2} = 1$ is $(x^2 + y^2)(k_1 y^2 - k_2 x^2) = (k_3)^2 x^2 y^2$, then the value of $(k_1 + k_2 + k_3)$ is -

(1) 11

(2) 13

(3) 6

(4) 4

17) If $0 < \theta < \pi$, then minimum value of $3 \sin \theta + \operatorname{cosec}^3 \theta$ is :-

(1) 4

(2) 3

(3) 5

(4) 6

18)

The value of k , for which $(\cos x + \sin x)^2 + k \sin x \cos x - 1 = 0$ is an identity, is

(1) -1

(2) -2

(3) 0

(4) 1

19) Vector $\hat{a}$ in the plane of $\vec{b} = 2\hat{i} + \hat{j}$ and $\vec{c} = \hat{i} - \hat{j} + \hat{k}$ is such that it is equally inclined to $\vec{b}$ and $\vec{d}$ where $\vec{d} = \hat{j} + 2\hat{k}$. The value of $\hat{a}$ is :-

(1) $\frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{3}}$

(2) $\frac{\hat{i} - \hat{j} + \hat{k}}{\sqrt{3}}$

(3) $\frac{2\hat{i} + \hat{j}}{\sqrt{5}}$

(4) None

20) Let $P_1 : x + y + 2z - 3 = 0$ and $P_2 : x - 2y + z = 4$ be two planes. Also, let $A(1, 3, 4)$ and $B(3, 2, 7)$ be two points in space. The equation of plane which passes through line of intersection of P_1 and P_2 and upon which length of projection of the line segment AB is the least, is :-

(1) $x + 3y + z + 2 = 0$

(2) $3y + z + 1 = 0$

(3) $2x - y + 3z - 7 = 0$

(4) $3x - 3y + 4z - 11 = 0$

21) A sample of 40 observation has the mean 10 and S.D. as 3. A second sample of 60 observation has mean 10 & S.D. 2 then variance of combined sample is

(1) 5

(2) 6

(3) 10

(4) None

22) Let R_1 and R_2 be the two relation defined on set of natural numbers N such that

$R_1 = \{(a, b) : a, b \in N, |a - b| \leq 13\}$ and

$R_2 = \{(a, b) : a, b \in N, |a - b| \neq 13\}$

Then

(1) Both R_1 and R_2 are equivalence relations

(2) Neither R_1 nor R_2 is an equivalence relation

(3) R_1 is an equivalence relation but R_2 is not

(4) R_2 is an equivalence relation but R_1 is not

23) Let $S = \{1, 2, 3, \dots, 100\}$. The number of non-empty subsets A of S such that the product of elements in A is even is :-

(1) $2^{50}(2^{50}-1)$

(2) $2^{100}-1$

(3) $2^{50}-1$

(4) $2^{50}+1$

24) Let $a, b, c \in R$ and a, b are the real roots of the equation $ax^2 + bx + c = 0$ and if $a + b + c < 0$, $a - b + c < 0$ and $c > 0$ then $[\alpha] + [\beta]$ is equal to :

(where $[.]$ denotes the greatest integer function.)

(1) -1

- (2) 3
(3) 4
(4) 2

25) Let $A = [a_{ij}]$ be a 3×3 invertible matrix. If determinant value of matrix A is 3, then the value of $\det((\text{adj} A^T)^T) + \det((\text{adj} A^{-1})^{-1})$ (where $\det(B)$ denotes determinant value of matrix B)-

- (1) 3
(2) 6
(3) 9
(4) 18

26) If the value of $\begin{vmatrix} x & y & 1 \\ -y & x & x \\ 2 & 3 & y \end{vmatrix} = 2$, then the value of is $\begin{vmatrix} x(y-3) & y^2+2x & -(3y+2x) \\ 3-y^2 & xy-2 & 2y-3x \\ x(y-1) & -(x^2+y) & x^2+y^2 \end{vmatrix}$

- (1) 3
(2) 4
(3) 2
(4) 5

27) How many words can be made from the letter of the word "DANGAL" if both 'A' come together but never come with 'L'.

- (1) 24
(2) 28
(3) 36
(4) 72

28) If two events A and B are such that $P(A^c) = 0.3$, $P(B) = 0.4$ and $P(A \cap B^c) = 0.5$, then value of $P\left[\frac{B}{A \cup B^c}\right]$ is equal to ?

- (1) $\frac{1}{4}$
(2) $\frac{1}{2}$
(3) $\frac{3}{4}$
(4) $\frac{3}{8}$

29) The range of the function $f(x) = e^{(\sqrt{x-3} + \sqrt{7-x})}$ is:

- (1) $[e^{\sqrt{2}}, e^2]$

(2) $[e^2, e^{2\sqrt{2}}]$

(3) $[e^{2\sqrt{2}}, e^4]$

(4) $[e^2, \infty)$

30) If $x = \sin(2 \tan^{-1} 2)$, $y = \sin\left(\frac{1}{2} \tan^{-1} \frac{4}{3}\right)$, then -

(1) $x = 1 - y$

(2) $x^2 = 1 - y$

(3) $x^2 = 1 + y$

(4) $y^2 = 1 - x$

31) $\lim_{x \rightarrow -\infty} \frac{5x + 9}{\sqrt{101 + 100x^2 + 5x}} =$

(1) 5

(2) $\frac{1}{3}$

(3) 1

(4) -1

32) Value of $f(0)$ so that $f(x) = \frac{\cos\left(\pi\left(\frac{\sqrt{x+1}-\sqrt{x}}{2}\right)\right)}{\sqrt{x}}$ can be made continuous at $x = 0$, is

(1) $\frac{\pi}{4}$

(2) $\frac{\pi}{2\sqrt{2}}$

(3) $\frac{\pi}{2}$

(4) π

33)

Number of points where

$$f(x) = (x - 1)|x^2 - 3x + 2| + \cos|x| + \sin|x|$$

is non differentiable is -

(1) 0

(2) 1

(3) 2

(4) 3

34) If $2x^y + 3y^x = 20$, then $\frac{dy}{dx}$ at (2, 2) is equal to:

- (1) $-\left(\frac{2 + \log_e 8}{3 + \log_e 4}\right)$
 (2) $-\left(\frac{3 + \log_e 16}{4 + \log_e 8}\right)$
 (3) $-\left(\frac{3 + \log_e 8}{2 + \log_e 4}\right)$
 (4) $-\left(\frac{3 + \log_e 4}{2 + \log_e 8}\right)$

35)

If, $\int \frac{x + \cos 2x + 1}{x \cos^2 x} dx = f(x) + K \cdot \ln|x| + C$. Where $f\left(\frac{\pi}{4}\right) = 1$, then $f(0) + 10K$ is equal to

- (1) 0
 (2) 10
 (3) 20
 (4) 21

36) Let $I_1 = \int_0^1 \cot^{-1}(1 - x + x^2) dx$ and $I_2 = \int_0^1 \tan^{-1} x dx$. Then I_1/I_2 :-

- (1) 2
 (2) 1
 (3) 1/2
 (4) None

37) Let $y = y(x)$ be the solution of the differential equation $\frac{dy}{dx} = 2x(x + y)^3 - x(x + y) - 1$, $y(0) = 1$.
 Then, $\left(\frac{1}{\sqrt{2}} + y\left(\frac{1}{\sqrt{2}}\right)\right)^2$ equals :

- (1) $\frac{4}{4 + \sqrt{e}}$
 (2) $\frac{3}{3 - \sqrt{e}}$
 (3) $\frac{2}{1 + \sqrt{e}}$
 (4) $\frac{1}{2 - \sqrt{e}}$

38) Area lying in the first quadrant between the curves $x^2 + y^2 = \pi^2$ and $y = \sin x$ and y-axis is equal to :-

- (1) $\frac{(\pi^2 - 8)}{2}$

(2) $\frac{(\pi^3 - 8)}{3}$

(3) $\frac{(\pi^2 - 8)}{4}$

(4) $\frac{(\pi^3 - 8)}{4}$

39) The length of the tangent to the curve $x = a \left(\cos t + \log \tan \frac{t}{2} \right)$, $y = a \sin t$ is

(1) ax

(2) ay

(3) a

(4) xy

40) Let $f(x)$ be a differentiable function and $|f'(x)| \leq 2$ for all x . If $f(1) = 2$ and $f(4) = 8$ then the value of $f(2)$ is :-

(1) 2

(2) 1

(3) 3

(4) 4

ANSWER KEYS

PHYSICS

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	1	3	4	2	3	1	1	2	1	4	2	1	2	4	4	1	4	3	1	3
Q.	21	22	23	24	25	26	27	28	29	30										
A.	1	2	1	2	1	2	4	3	4	3										

CHEMISTRY

Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A.	1	1	3	2	4	3	1	4	3	3	4	3	3	4	1	1	3	4	3	3
Q.	51	52	53	54	55	56	57	58	59	60										
A.	3	3	1	4	3	2	2	4	3	3										

ENGLISH PROFICIENCY

Q.	61	62	63	64	65	66	67	68	69	70
A.	2	1	3	4	2	1	3	3	4	2

LOGICAL REASONING

Q.	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
A.	2	4	4	1	2	3	2	3	2	1	1	2	4	2	2	2	3	3	3	1

MATHEMATICS

Q.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
A.	1	2	1	4	2	4	4	3	4	1	2	2	3	3	1	3	1	2	2	3
Q.	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
A.	2	2	2	1	4	2	4	1	2	4	4	3	3	1	3	1	4	4	3	4

SOLUTIONS

PHYSICS

1) $[\text{Energy}] = [\text{ML}^2\text{T}^{-2}]$

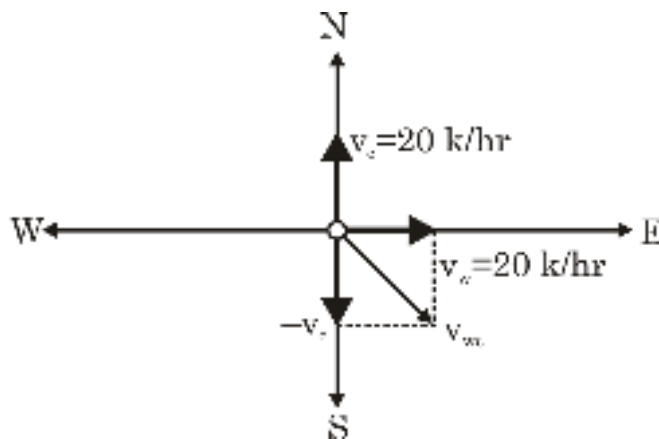
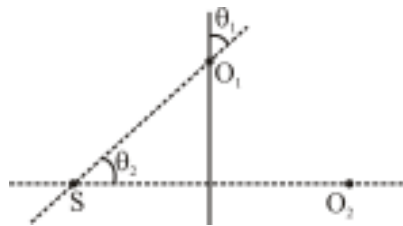
$1 \text{ eluoj} = 1 \times (100 \text{ kg}) \times (1 \text{ km})^2 \times (100 \text{ sec})^{-2}$
 $\Rightarrow 1 \text{ eluoj} = 10^4 \text{ kg m}^2\text{s}^{-2} = 10^4 \text{ J}$

2) Slope = $\frac{dx}{dt}$ = velocity

3) $f_1 = f_0 \left(\frac{V - V_0 \cos \theta_1}{V + V_1 \cos \theta_2} \right)$

$f_2 = f_0 \left(\frac{V - V_0}{V + V_1} \right)$

$f_1 > f_2 \Rightarrow \frac{f_1}{f_2} > 1$



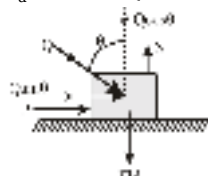
5)

Flag will flutter in the direction of wind wrt car
 South East

6)

Applied force

$f_a = P + Q \sin \theta$



Normal reaction

$N = mg + Q \cot \theta$

$$f_0 = \mu N = \mu(mg + Q \cos \theta)$$

Now, condition for no slipping

$$f_a \leq f_0$$

$$P + Q \sin \theta \leq \mu(mg + Q \cos \theta)$$

$$\mu \geq \frac{P + Q \sin \theta}{mg + Q \cos \theta}$$

7)

Question Explanation : A sonometer string vibrates in its third overtone. Given length, tension, and mass per unit length, find the frequency.

Concept: Standing waves on stretched string

Solution:

Given:

Length between bridges,

$$L = 40 \text{ cm} = 0.40 \text{ m}$$

Tension,

$$T = 90 \text{ N}$$

Mass per unit length,

$$\mu = 0.01 \text{ kg/m}$$

Velocity of transverse wave on the string:

$$v = \sqrt{T / \mu}$$

$$v = \sqrt{90 / 0.01}$$

$$v = \sqrt{9000}$$

$$v \approx 95 \text{ m/s}$$

Third overtone corresponds to fourth harmonic, so

$$n = 4$$

Frequency of nth harmonic:

$$f_n = n v / (2L)$$

$$f_4 = (4 \times 95) / (2 \times 0.40)$$

$$f_4 = 380 / 0.80$$

$$f_4 = 475 \text{ Hz}$$

Final Answer: Option (1)

$$8) T_1 \sin 30 + T_2 \sin 60 = 50$$

$$T_1 \cos 30 = T_2 \cos 60$$

$$T_1 + \sqrt{3}T_2 = 100 \dots\dots\dots(i)$$

$$\sqrt{3} T_1 = T_2 \dots\dots\dots(ii)$$

From (i) & (ii)

$$T_1 = 25 \text{ N}$$

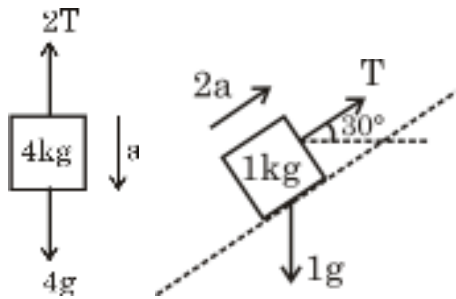
$$T_2 = 25 \sqrt{3} \text{ N}$$

9)

Explanation the Question : We have to find work done by tension on a 1kg block when the 4 kg block moves down by 1 m.

Concept: This question is based on calculation of work.

Solution:



$$-2T + 4g = 4a \quad T - g\sin 30^\circ = 2a$$

Thus, $T = \frac{5g}{4}$

Distance moved by 1 kg block when 4 kg block moves down by 1m is 2m $\square$ $W = \frac{5g}{4} \times 2 = 25 \text{ J}$

Final Answer: 1

11) $t = \frac{d}{V_{M/R}} = \frac{60}{4} = 15 \text{ sec}$

12) $J - J' = mv$

$J' = 2mv$

$\Rightarrow v = \frac{J}{3m}$

14) $I_1 = I_2 = I_3 = I_4 = \frac{2}{3}mR^2$

$I_2 = I_{cm} + m(d)^2 = I_4$

$d = \frac{r}{2}$

15) $\frac{v}{x_1} = \frac{2v}{x_1 + L}$

$\Rightarrow x_1 = L$

$\frac{2v}{x_2} = \frac{v}{L - x_2}$

$x_2 = \frac{2L}{3}$

$\square \frac{x_1}{x_2} = \frac{3}{2}$

17) $S = \frac{MLT^{-2}}{[L]} = M^1 L^0 T^{-2}$

18)

Question Explanation: Bubbles form at the bottom of a heated vessel as spheres of radius R , making a small circular contact of radius r . Find r just before detachment considering surface tension.

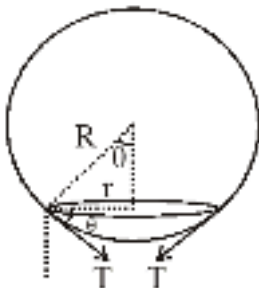
Concept: This question is based on balance of buoyant force and surface tension ($F_{\text{buoy}} = F_{\text{surface}}$).

Solution:

Force due to Surface Tension

$$= T (2\pi r) \sin \theta$$

$$= T (2\pi r) \times \frac{r}{R}$$



This force will balance the force of Buoyancy

$$T (2\pi r) \times \frac{r}{R} = \rho_w \times \frac{4}{3} \pi R^3 g$$

$$r = R^2 \sqrt{\frac{2\rho_w g}{3T}}$$

Final Answer: The correct option is (3).

19)

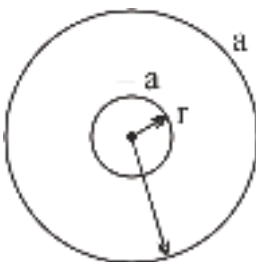
Maximum separation = $2A \sin(\phi/2)$

$$\Rightarrow \phi = 60^\circ$$

$$\text{at } t = \frac{T}{12} \quad \phi = \frac{\pi}{3}$$

$$x = A \sin \frac{\pi}{3} = \frac{a\sqrt{3}}{2}$$

22) O - r potential is constant $\frac{\sigma}{\epsilon_0} (R - r)$ from r to R it increases



we are moving opposite to field from $R \infty$ it decreases.

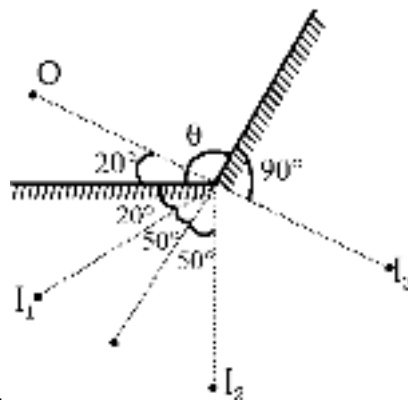
23)

By analogy with SHM, $\left(\frac{dl}{dt}\right)_{\max}$ is analogous to $a_{\max}$.

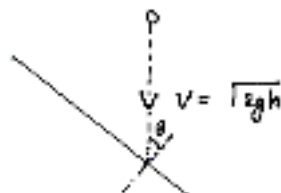
Since $a_{\max} = \omega^2 A$

$$\left(\frac{dl}{dt}\right)_{\max} = \omega^2 q_0 = \frac{q_0}{LC}$$

24)



By ray diagram



$$e = 1 = \frac{V^1}{V \cos \theta}$$

$$V' = V \cos \theta$$

$$\Delta p = 2mv \cos \theta$$

$$= 2m \cos \theta \sqrt{2gh}$$

26)

Explain the question : We have to find the magnitude F_0 in graph where F - t graph is given.

Concept : This question is based on collision

Solution :-

for one dimensional head on elastic collision the blocks interchange their velocities

$$I = \int F dt = mu$$

$$\frac{1}{2} F_0 T = mu$$

$$F_0 = \frac{2mu}{T}$$

Final answer : option (2)

29) **Question Explanation:** Identify the logic circuit corresponding to the given truth table.

Concept: Logic gates and truth tables.

Solution:

Combination logic gates as per the table given

				0	1	1	
				1	0	0	
				1	0	1	
				1	1	0	
Given case	0	1	0	other case	1	1	1

Output $Y = 0$ only for $A = 0, B = 1, C = 0$; $Y = 1$ for all other cases.

Testing shows that the circuit in Option 4 satisfies this condition.

Its Boolean expression simplifies to: $Y = A + B'C + A'C + BC$

which gives $Y = 0$ only when $A = 0, B = 1, C = 0$.

So option 4 is correct

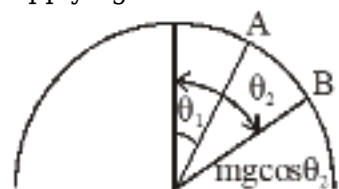
30)

Solution:

At B, normal becomes zero.

$$\text{So, } V_B = \sqrt{gR \cos \theta_2} \quad \dots(i)$$

Applying COE at A and B



$$-mgR(1 - \cos \theta_1) = -mgR(1 - \cos \theta_2) + \frac{1}{2}mv_B^2$$

$$mgR \cos \theta_1 = mgR \cos \theta_2 + \frac{1}{2}mgR \cos \theta_2$$

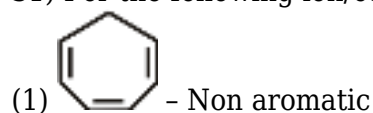
$$mgR \cos \theta_1 = \frac{3mgR \cos \theta_2}{2}$$

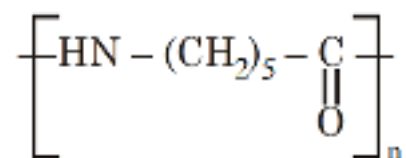
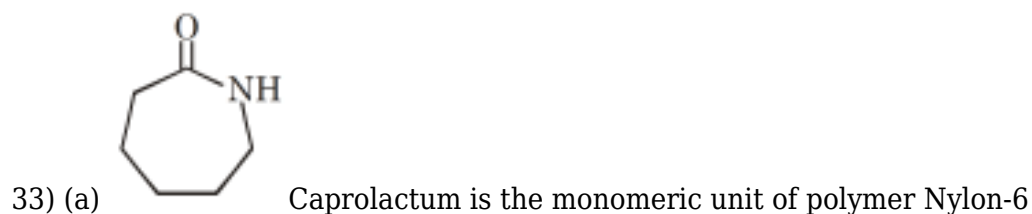
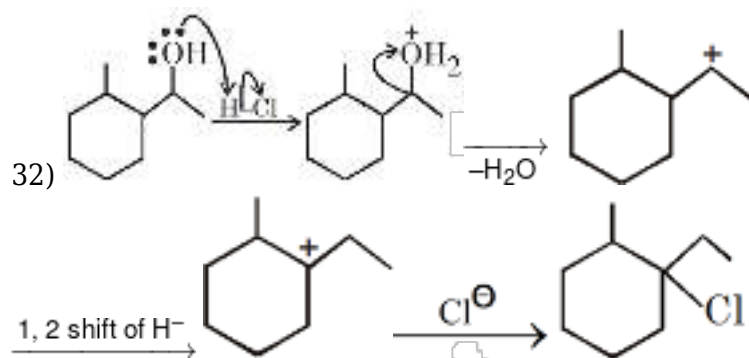
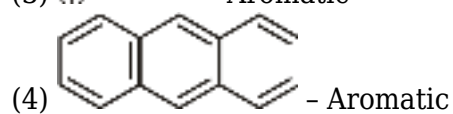
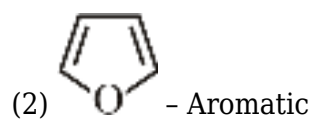
$$\Rightarrow \cos \theta_2 = \frac{2}{3} \cos \theta_1$$

Final Answer: The correct option is (3).

CHEMISTRY

31) For the following ion/compounds

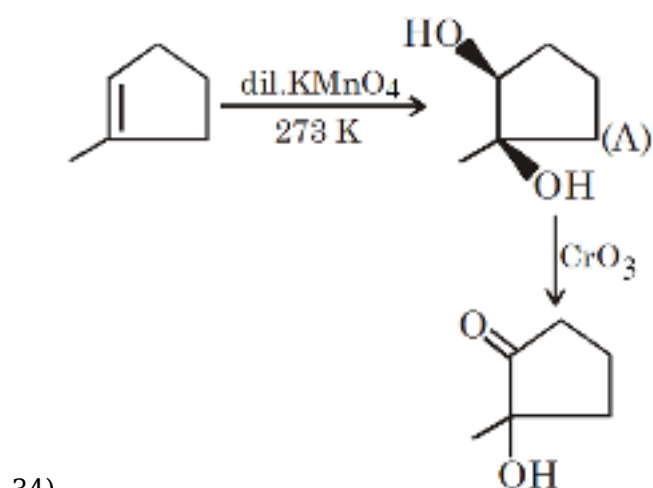




(b) 2-Chlorobuta-1, 3-diene is the monomeric unit of polymer neoprene.

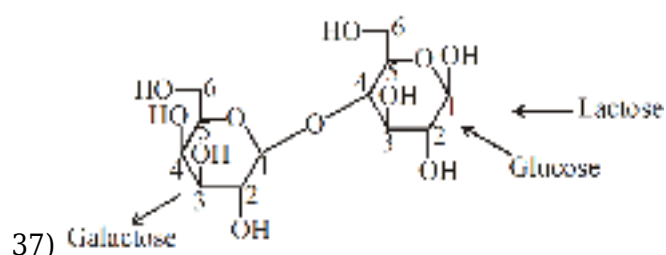
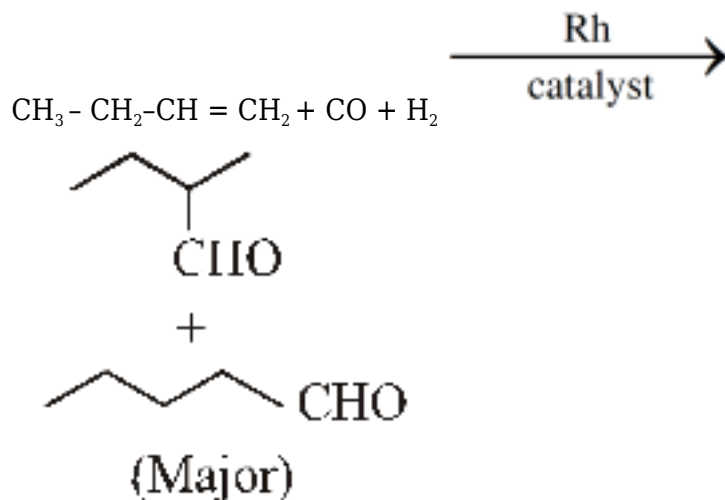
(c) 2-Methylbuta-1, 3-diene is the monomeric unit of polymer natural rubber.

(d) $\text{CH}_2 = \text{CH} - \text{CN}$ (Acrylonitrile) is the one of the monomeric unit of polymer Buna-N



35) The gas CH_4 evolved due to anaerobic degradation of vegetation which causes global warming and cancer.

36) OXO PROCESS (Hydroformylation)



In lactose linkage is formed between C_1 of galactose and C_4 of glucose.

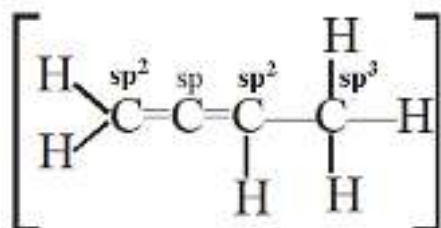
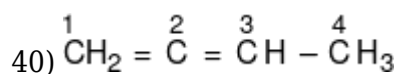
38) **Statement 1** : B.P. of chloroform = 334 K

B.P. of aniline = 457 K

thus can be separated of simple distillation.

Statement 2 : Mixture of aniline and water separated by steam distillation.

39) Ceric ammonium nitrate for alcohol and CHCl_3/KOH is carbyl amine test for primary amines.



41) $m = \frac{1000}{78} = 12.82$

42)

Question Explanation: Find the ratio of time.

Concept : This question is based on Bohr Model

Solution:

$$r = 0.529 \frac{n^2}{Z^2} A^\circ$$

$$\frac{r_1}{r_2} = \left(\frac{n_1}{n_2} \right)^2 = \frac{R}{4R}$$

$$\frac{n_1}{n_2} = \frac{1}{2}$$

$$\text{Time period of Revolution} = \frac{2\pi r}{v}$$

$$r \propto \frac{n^2}{Z^2}; v \propto \frac{Z}{n}$$

$$T \propto \frac{n^3}{Z^2}$$

$$Z = 1$$

$$\frac{T_1}{T_2} = \left(\frac{n_1}{n_2} \right)^3 = \left(\frac{1}{2} \right)^3 = \frac{1}{8}$$

Final Answer:

option (3)

43) **Question Explanation:**

Formula for equilibrium concentration of product.

Concept:

This question is based on equilibrium constant.

Solution:



$$K_c = \frac{K_f}{K_b} = \frac{[B]_e}{[A]_e}$$

$$\begin{aligned} [B]_e &= \frac{K_f}{K_b} [A]_e \\ &= K_f K_b^{-1} [A]_e \end{aligned}$$

Final Answer:

The correct option is (3).

45)

$$\pi = i CRT$$

$$2 = i \times .02 \times 0.082 \times 400$$

$$i = 3$$

$$i = 1 - \alpha + n\alpha$$

$$3 = 1 - \alpha + 3\alpha$$

$$\alpha = 1, 100\%$$

46)

Explain Question : Calculate E_a from k quadrupling over 300 K to 310 K.

Concept : This question is based on two-point Arrhenius equation (Natural log).

Solution : The rate (and k) quadruples, so $\frac{k_2}{k_1} = 4$.
Given $T_1 = 300$ K.

$$\text{Use the natural log form : } \ln \left(\frac{k_2}{k_1} \right) = \frac{E_a}{R} \left(\frac{T_2 - T_1}{T_1 T_2} \right).$$

$$= \frac{E_a}{8.314} \left(\frac{10}{300 \times 310} \right).$$

Substituting values : $\ln(4)$

$$\text{Since } \ln(4) = \ln(2^2) = 2 \ln(2) = 2 \times 0.693 = 1.386$$

$$= \frac{E_a}{8.314} \left(\frac{10}{300 \times 310} \right).$$

$$\Rightarrow 1.386$$

Rearranging for E_a :

$$E_a = \frac{1.386 \times 8.314 \times 93000}{10} \approx 107204 \text{ J mol}^{-1}.$$

Converting to KJ mol^{-1} : $E_a \approx 107.2 \text{ kJ mol}^{-1}$.

Final answer : Option (1)

47) **Question Explanation :** Calculate gas enthalpy change.

Concept: $\Delta H = [\gamma/(\gamma - 1)]\Delta(PV)$.

Solution: Enthalpy (H) is a state function for an ideal gas, meaning its change depends solely on the initial and final states, regardless of the complex intermediate path shown in the $P - V$ diagram. For an ideal gas, the enthalpy change is given by $\Delta H = nC_p\Delta T$. Since $PV = nRT$ for an ideal gas, we can substitute

$$nR\Delta T = \Delta(PV) = P_B V_B - P_A V_A, \text{ leading to } \Delta H = \frac{C_p}{R} (P_B V_B - P_A V_A). \text{ The ratio } C_p/R$$

can be expressed as $\frac{\gamma}{\gamma - 1}$. Given $\gamma = 4/3$, this ratio is $\frac{4/3}{4/3 - 1} = 4$. From the graph, state A is (1 atm, 1 L) and state B is (1 atm, 4 L). Calculating the change,
 $\Delta H = 4 \times (1 \times 4 - 1 \times 1) = 4 \times 3 = 12 \text{ atm-L}.$

Final answer : Option (3) 12 atm-L

48)

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$-RT \ln K_{eq} = -66.5 \times 10^3 - 298\Delta S^\circ$$

$$-8.314 \times 298 \ln(10^3) = -66.5 \times 10^3 - 298\Delta S^\circ$$

$$\frac{2.303 \times 8.314 \times 298 \times 3 - 66.5 \times 10^3}{298} = \Delta S^\circ$$

$$\Delta S^0 = -0.165 \text{ kJ mol}^{-1} \text{ K}^{-1}$$

$$\begin{aligned} 49) \% h &= \sqrt{\frac{K_w}{K_a \times C}} \times 100 \\ &= \sqrt{\frac{10^{-14}}{10^{-5} \times 10^{-1}}} \times 100 \\ &= 10^{-2} = 0.01 \% \end{aligned}$$

50) Question Explanation:

Question is asking about the equivalent conductance of the electrolyte at infinite dilution

Concept:

This question is based on application of Kohlrausch law

Solution:

$$K_a = C\alpha^2$$

$$\sqrt{\frac{K_a}{C}} = \alpha$$

$$\sqrt{\frac{25 \times 10^{-6}}{0.01}} = 5 \times 10^{-2}$$

$$\alpha = 0.05$$

$$\alpha = \frac{\Lambda}{\Lambda^\circ}$$

$$\Lambda^\circ = \frac{19.6}{0.05} = 392$$

Final Answer:

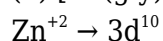
The correct option is (3)

51) Which order is wrong. (C) Basic nature - $\text{CaO} > \text{MgO} > \text{FeO} > \text{Fe}_2\text{O}_3$

52) BrF_5 is polar molecule which have sp^3d^2 hybridisation.

53) Solution:

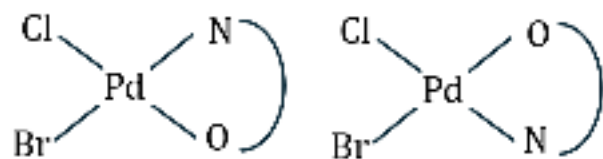
(1) $[\text{Zn}(\text{gly})_2]$

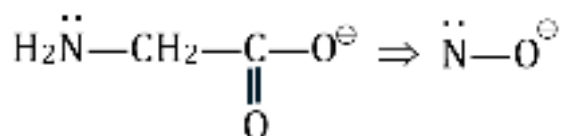


Hybridization = sp^3

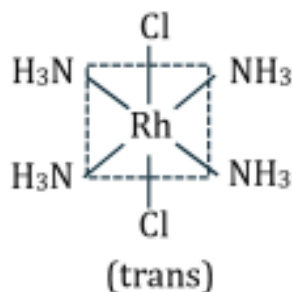
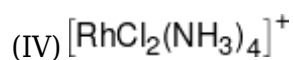
tetrahedral unsymmetrical bidentate ligand } optically active

(ii) $[\text{PdClBr}(\text{gly})^-]$ has square planar geometry





It can show G.I.



G.I. = 2

O.I. = 0

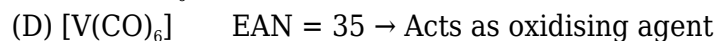
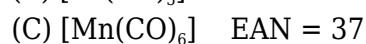
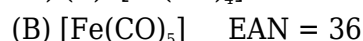
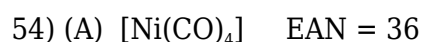
$$\text{S.I.} = \text{G.I.} + \text{O.I.}$$

$$= 2 + 0$$

$$\text{S.I.} = 2$$

$$\text{S.I.} = \text{G.I.} = 2$$

Final Answer: Option (1)



55) **Solution:**

(I) Van Arkel Method → Ti, Zr, Hf

(II) Zone refining → Se, Ge

(III) liquation → Sn, Pb, & Bi

(IV) Mond process → Ni

56)

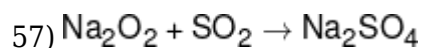
Explain question : Select the radicals which identify by dilute HCl + H₂S

Concept : This question is based on Test for basic radicals group -2

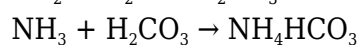
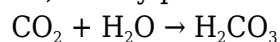
Solution :-

II - group cations gives precipitate wit dil HCl + H₂S

ex. Pb⁺², Cu⁺², Bi⁺², Hg⁺², Cd⁺²



58) Solvay process involve following reactions





59) **Question Explanation:** Identifying the ion with an observed magnetic moment in the range of 4.4 - 5.2 BM.

Concept: Magnetic Moment of Complexes.

Ion	Observed magnetic moment (BM)
Fe^{2+}	5.3 - 5.5
Mn^{2+}	5.96
Co^{2+}	4.4 - 5.2
Ni^{2+}	2.9 - 3.4

Final Answer: 3. Co^{2+} .

60)

pH of rain water is 5.6 due to dissolved CO_2

ENGLISH PROFICIENCY

61) The correct answer is (2)

62) The correct answer is (1)

63) The correct answer is (3)

64) The correct answer is (4)

65) The correct answer is (2)

66) The correct answer is (1)

67) The correct answer is (3)

68) The correct answer is (3)

69) The correct answer is (4)

70) The correct answer is (2)

LOGICAL REASONING

71) The correct answer is (2)

72) The correct answer is (4)

73) The correct answer is (4)

74) The correct answer is (1)

75) The correct answer is (b)

76) The correct answer is (3)

77) The correct answer is (2)

78) The correct answer is (3)

79) Correct answer is (2)

80) The correct answer is (1)

81) The correct answer is (1)

82) The correct answer is (2)

83) The correct answer is (4)

84) The correct answer is (2)

85) The correct answer is (2)

86) The correct answer is (2)

87) The correct answer is (3)

88)

The correct answer is (3)

89) The correct answer is (3)

90) The correct answer is (1)

MATHEMATICS

Here $V = \frac{4}{3}\pi r^3$ and $S = 4\pi r^2$

$$\rightarrow \frac{dV}{dt} = 4\pi r^2 \frac{dr}{dt} \rightarrow \frac{dr}{dt} = \frac{10}{4\pi r^2} = \frac{5}{32\pi}$$

91) $\therefore \frac{dS}{dt} = 8\pi \frac{dr}{dt} = 8\pi \times 8 \times \frac{5}{32\pi} = 10.$

92) $f(1) = 1(0-2) = -2$
 $f(e^2) = e^2(2-2) = 0$
 $f'(x) = \ln x - 2 + x \cdot \frac{1}{x} = 0 \Rightarrow \ln x = 1 \Rightarrow x = e$
 $\therefore f(e) = e(1-2) = -e$
Difference = e

93) Corner pts (80, 0) (40, 20) (20, 50) (0, 100)
Min Z = 220 at (40, 20)

94)

Question Explanation: Translating a complex English sentence into symbolic logic notation.

Concept: Mathematical Reasoning - Conditional Statements.

Solution:

Antecedent: Ramesh listens to music (p).

Consequent Part 1: In his village ($\sim q$).

Consequent Part 2: Sunday or Saturday ($r \vee s$).

Full Consequent: $(\sim q) \wedge (r \vee s)$.

Symbolic Form: $p \Rightarrow ((\sim q) \wedge (r \vee s))$.

Final Answer: Option (4)

95) $|a| + |b| = |a + b|$

$$ab \geq 0$$

$$(x^2 + 5x)(x - x^2) \geq 0$$

$$x^2(x + 5)(x - 1) \leq 0$$



$$x \in [-5, 1]$$

$$NO = 7$$

$$96) \left(\frac{1}{2}\right)^{x^6 - 2x^4} < 2^{x^2}$$

$$(2)^{2x^4 - x^6} < 2^{x^2}$$

$$2x^4 - x^6 < x^2$$

Solve

97)

take case

$$\text{case (1) } x > 0 \Rightarrow |x| = x$$

$$\text{case (2) } x < 0 \Rightarrow |x| = -x$$

98) **Question Explanation:** We have to find the value of given expression using difference method.

Concept: This question is based on method of difference - write general term of the series as difference of two terms.

$$f(n) = \prod_{r=1}^n 2^{r \cdot r!}$$

Solution:

$$\text{Here } r \cdot r! = (r + 1 - 1) r!$$

$$= (r + 1)r! - r!$$

$$= (r + 1)! - r!$$

$$2^{r \cdot r!} = \frac{2^{(r+1)!}}{2^{r!}}$$

$$f(n) = \prod_{r=1}^n 2^{r \cdot r!} = \prod_{r=1}^n \frac{2^{(r+1)!}}{2^{r!}}$$

$$= \frac{2^{2!}}{2^{1!}} \times \frac{2^{3!}}{2^{2!}} \times \frac{2^{4!}}{2^{3!}} \times \dots \times \frac{2^{(n+1)!}}{2^{n!}}$$

$$f(n) = \frac{2^{(n+1)!}}{2^{1!}}$$

$$f(2015) = \frac{2^{2016!}}{2}$$

$$\log_2 2 + (2015) = \log_2 2^{(2016)!} = (2016)!$$

$$\frac{1}{(2016)!} \log_2 (2 + (2015)) = \frac{1}{(2016)!} \times (2016)! = 1$$

Final answer: The correct option is (3).

99)

common roots = w, w^2

so $w + w^2 = -1$

$$100) \left[x - \frac{(n+1)}{1} \right] \left[\frac{x}{2} - \frac{(n+1)}{2} \right] \left[\frac{x}{3} - \frac{(n+1)}{3} \right] \dots \left[\frac{x}{n} - \frac{(n+1)}{n} \right] = [x - (n+1)]^n \text{ Coefficient of } x^{n-6} \text{ is } {}^nC_6(n+1)^6$$

101) $S_{2n} = 3S_n$

$$\Rightarrow \frac{2n}{2} \{2a + (2n-1)d\} = 3 \frac{n}{2} \{2a + (n-1)d\}$$

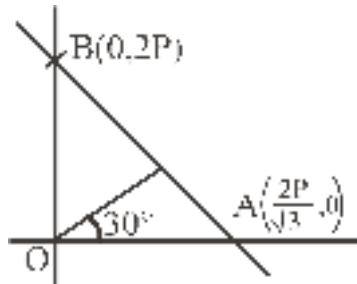
$$\Rightarrow 2a = (n+1)d \quad \dots(1)$$

$$\frac{S_{3n}}{S_n} = \frac{\frac{3n}{2} \{2a + (3n-1)d\}}{\frac{n}{2} \{2a + (n-1)d\}} = \frac{3 \{2a + (3n-1)d\}}{\{2a + (n-1)d\}}$$

$$\begin{aligned} &= \frac{3 \{(n+1)d + (3n-1)d\}}{\{(n+1)d + (n-1)d\}} \quad (\text{using (1)}) \\ &= \frac{12nd}{2nd} = 6 \end{aligned}$$

102) Let P be the length of the perpendicular from the origin on the given lines. Then its equation in normal form is $x \cos 30^\circ + y \sin 30^\circ = P$

or $\sqrt{3}x + y = 2P$



This meets the coordinate axes at $A\left(\frac{2P}{\sqrt{3}}, 0\right)$ and $B(0, 2P)$,

□ Area of ΔOAB

$$= \frac{1}{2} \cdot \left(\frac{2P}{\sqrt{3}}\right) \cdot (2P) = \frac{2P^2}{\sqrt{3}}$$

$$\frac{2P^2}{\sqrt{3}} = \frac{50}{\sqrt{3}} \Rightarrow P = \pm 5$$

Hence the lines are $\sqrt{3}x + y \pm 10 = 0$

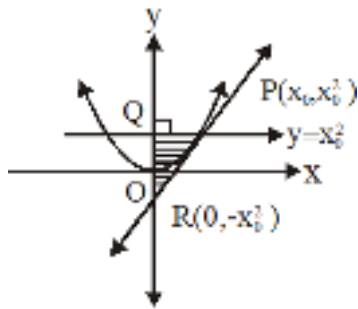
103) (3, 4) and (1, 2) are end pts of dia

so eqⁿ of circle

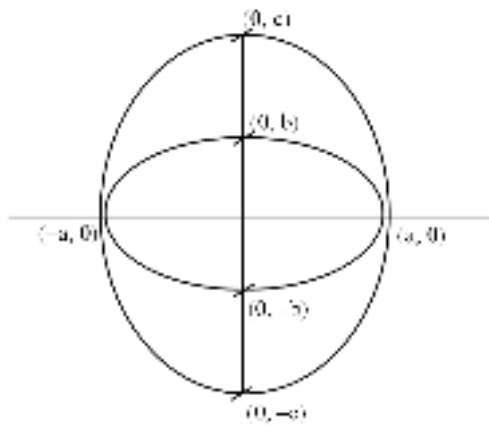
$$(x-3)(x-1) + (y-4)(y-2) = 0$$

$$x^2 + y^2 - 4x - 6y + 11 = 0$$

$$104) \text{Area} = \frac{1}{2} \times PQ \times QR = \frac{1}{2} \times x_0 2x_0^2 = x_0^3$$



$$(\text{Area})_{\max} = 8, \text{ when } x_0 = 2$$



$$e^2 = 1 - \frac{b^2}{a^2}$$

105)

$$e^2 = 1 - \frac{b^2}{a^2}$$

$$\Rightarrow \frac{b^2}{a^2} = \frac{a^2}{c^2}$$

$$\Rightarrow c^2 = \frac{a^4}{b^2} \Rightarrow c = \frac{a^2}{b}$$

$$\text{Also } b = ce$$

$$\Rightarrow c = \frac{b}{e}$$

$$\frac{b}{c} = \frac{a^2}{b}$$

$$\Rightarrow e = \frac{b^2}{a^2} = 1 - e^2$$

$$\Rightarrow e^2 + e - 1 = 0$$

$$\Rightarrow e = \frac{-1 + \sqrt{5}}{2}$$

$$106) \frac{x^2}{1} - \frac{y^2}{2} = 1$$

The equation of the normal to this curve at $(\sec \theta, \sqrt{2} \tan \theta)$ is

$$x \cos \theta + \sqrt{2} y \cot \theta = 3 \quad \dots(I)$$

Let the foot of perpendicular from centre upon the normal be (h, k).

Equation of normal can also be written as

$$hx + ky = h^2 + k^2 \quad \dots(ii)$$

Comparing equation (i) and (ii)

$$\frac{\cos \theta}{h} = \frac{\sqrt{2} \cot \theta}{k} = \frac{3}{h^2 + k^2}$$

$$\Rightarrow \sec \theta = \frac{h^2 + k^2}{3h}, \quad \tan \theta = \frac{\sqrt{2}(h^2 + k^2)}{3k}$$

$$\Rightarrow \frac{(h^2 + k^2)^2}{9h^2} - \frac{2(h^2 + k^2)^2}{9k^2} = 1$$

$$(x^2 + y^2)^2 (y^2 - 2x^2) = 9x^2 y^2$$

$$\Rightarrow \begin{matrix} k_1 = 1, & k_2 = 2, & k_3 = 3 \\ k_1 + k_2 + k_3 = 6 \end{matrix}$$

107) Using A.M. $\geq$ G.M.

$$\frac{\sin \theta + \sin \theta + \sin \theta + \operatorname{cosec}^3 \theta}{4} \geq (\sin^3 \theta \cdot \operatorname{cosec}^3 \theta)^{1/4}$$

Hence, minimum value of $3 \sin \theta + \operatorname{cosec}^3 \theta$ is 4.

108)

$$\text{Given, } (\cos x + \sin x)^2 + k \sin x \cos x - 1 = 0, \forall x$$

$$\Rightarrow \cos^2 x + \sin^2 x + 2 \cos x \sin x + k \sin x \cos x - 1 = 0, \forall x$$

$$\Rightarrow (k + 2) \cos x \sin x = 0, \forall x$$

$$\Rightarrow k + 2 = 0$$

$$\Rightarrow k = -2$$

$$109) \text{ Let } \vec{a} = \lambda \vec{b} + \mu \vec{c}$$

$\vec{a}$ is equally inclined to $\vec{b}$ and $\vec{d}$, where $\vec{d} = \hat{j} + 2\hat{k}$.

$$\Rightarrow \frac{\vec{a} \cdot \vec{b}}{|\vec{a}| |\vec{b}|} = \frac{\vec{a} \cdot \vec{d}}{|\vec{a}| |\vec{d}|}$$

$$\Rightarrow \frac{(\lambda \vec{b} + \mu \vec{c}) \cdot \vec{b}}{\sqrt{5}} = \frac{(\lambda \vec{b} + \mu \vec{c}) \cdot \vec{d}}{\sqrt{5}}$$

$$\Rightarrow \frac{[\lambda (2\hat{i} + \hat{j}) + \mu (\hat{i} - \hat{j} + \hat{k})] \cdot (2\hat{i} + \hat{j})}{\sqrt{5}}$$

$$= \frac{[\lambda (2\hat{i} + \hat{j}) + \mu (\hat{i} - \hat{j} + \hat{k})] \cdot (\hat{j} + 2\hat{k})}{\sqrt{5}}$$

$$\text{or } \lambda(4 + 1) + \mu(2 - 1) = \lambda(1) + \mu(-1 + 2)$$

$$\text{or } 4\lambda = 0, \text{ i.e., } \lambda = 0$$

$$\hat{a} = \frac{\hat{i} - \hat{j} + \hat{k}}{\sqrt{3}}$$

□

110) Equation of family of planes containing line of intersection of planes P_1 and P_2 is given by

$$(x + y + 2z - 3) + \lambda(x - 2y + z - 4) = 0$$

$$\text{or } (1 + \lambda)x + (1 - 2\lambda)y + (2 + \lambda)z - 3 - 4\lambda = 0$$

Projection of length of line segment is least if AB is perpendicular to read plane.

$$\square \quad \frac{1 + \lambda}{2} = \frac{1 - 2\lambda}{-1} = \frac{2 + \lambda}{3} \Rightarrow \lambda = 1$$

$$\square \quad \text{Equation of plane P is } 2x - y + 3z - 7 = 0$$

$$111) n_1 = 40, \bar{x}_1 = 10a, \sigma_1 = 3$$

$$n_2 = 60, \bar{x}_2 = 10a, \sigma_2 = 2$$

$$\text{combined mean } (\bar{x}) = \frac{n_1 \bar{x}_1 + n_2 \bar{x}_2}{n_1 + n_2} = 10$$

$$\begin{aligned} \text{combined variance} &= \frac{n_1 \sigma_1^2 + n_2 \sigma_2^2}{n_1 + n_2} \\ &= \frac{40(9) + 60(4)}{40 + 60} = \frac{360 + 240}{100} \\ &= 6 \end{aligned}$$

$$112) R_1 = \{(a, b) \in N \times N : |a - b| \leq 13\} \text{ and } R_2 = \{(a, b) \in N \times N : |a - b| \neq 13\}.$$

For R_1 :

(i) Reflexive relation

$$(a, a) \in N \times N : |a - a| \leq 13$$

(ii) Symmetric relation

$$(a, b) \in R_1, (b, a) \in R_1 : |b - a| \leq 13$$

(iii) Transitive relation

$$(a, b) \in R_1, (b, c) \in R_1, (a, c) \in R_1$$

$$(1, 3) \in R_1, (3, 16) \in R_1, \text{ but } (1, 16) \notin R_1$$

For R_2 :

(i) Reflexive relation

$$(a, a) \in N \times N : |a - a| \neq 13$$

(ii) Symmetric relation

$$(b, a) \in N \times N : |b - a| \neq 13$$

(iii) Transitive relation

$$(a, b) \in R_2, (b, c) \in R_2, (a, c) \in R_2$$

$$(1, 3) \in R_2, (3, 14) \in R_2, \text{ but } (1, 14) \notin R_2$$

113)

$$S = \{1, 2, 3, \dots, 100\}$$

= Total non empty subsets-subsets with product of element is odd

$$= 2^{100} - 1 - [(2^{50} - 1)]$$

$$= 2^{100} - 2^{50}$$

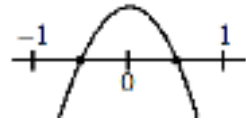
$$= 2^{50}(2^{50} - 1)$$

$$114) f(1) = a + b + c < 0$$

$$f(0) = c > 0$$

$$f(-1) = a - b + c < 0$$

□ Graph is



$$\alpha \in (-1, 0), \beta \in (0, 1)$$

$$[\alpha] + [\beta] = -1 + 0 = -1$$

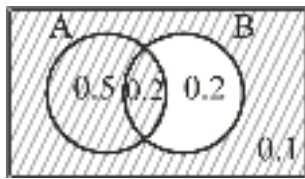
$$115) \det((\text{adj } A^T)^T) = \det(\text{adj } A^T) = (\det(A^T))^2$$

$$= (\det A)^2 = 9$$

$$\det((\text{adj } A^{-1})^{-1}) = \frac{1}{\det(\text{adj } A^{-1})} = \frac{1}{(\det(A^{-1}))^2} = (\det A)^2 = 9$$

116) Clearly 2nd determinant is determinant of cofactor of element in 1st determinant.

$$117) \textcircled{AA} \textcircled{D} * \textcircled{N} * \textcircled{G} * \angle 4. {}^3C_{1.1} = 72$$



118)

$P(A \cup B^c) = \text{Total case}$

= shaded region

$$\text{So, } P\left[\frac{B}{A \cup B^c}\right] = \frac{0.2}{0.8} = \frac{1}{4}$$

$$119) \text{Range} = [e^{\sqrt{b-a}}, e^{\sqrt{2(b-a)}}]$$

$$a = 3, b = 7$$

$$\text{Range} = [e^2, e^{2\sqrt{2}}]$$

$$120) x = \sin 2\theta = 2 \sin\theta \cos\theta = \frac{4}{5}, \text{ (where } \tan\theta = 2)$$

$$y = \sin \frac{\phi}{2}; y > 0, \text{ where } \tan\phi = \frac{4}{3}$$

$$\Rightarrow y^2 = \sin^2 \frac{\phi}{2} = \frac{1 - \cos\phi}{2} = \frac{1}{5} = 1 - x$$

$$\Rightarrow y^2 = 1 - x$$

$$121) \lim_{x \rightarrow -\infty} \frac{5x+9}{|x| \sqrt{\frac{101}{x^2} + 100} + 5x}$$

$$\begin{aligned}
&= \lim_{x \rightarrow -\infty} \frac{5x+9}{-x\sqrt{\frac{101}{x^2}+100}+5x} \\
&= \lim_{x \rightarrow -\infty} \frac{5x+\frac{9}{x}}{-\sqrt{\frac{101}{x^2}+100}+5} \\
&= \frac{5}{-10+5} \\
&= -1
\end{aligned}$$

$$\begin{aligned}
122) \quad f(0) &= \lim_{x \rightarrow 0} \frac{\sin\left(\frac{\pi}{2} - \frac{\pi}{2}(\sqrt{x+1} - \sqrt{x})\right)}{\sqrt{x}} \\
&= \lim_{x \rightarrow 0} \frac{\frac{\pi}{2}(1 + \sqrt{x} - \sqrt{x+1})}{\sqrt{x}} \\
&= \lim_{x \rightarrow 0} \frac{\frac{\pi}{2}(1+x+2\sqrt{x}-x-1)}{\sqrt{x}(1+\sqrt{x}+\sqrt{x+1})}
\end{aligned}$$

123)

It is non differentiable at $x = 2, 0$

124) Given,

$$2x^y + 3y^x = 20$$

Now differentiating both sides w.r.t. x , we get

$$2x^y \left(y' \ln x + \frac{y}{x} \right) + 3y^x \left(\ln y + \frac{x}{y} \cdot y' \right) = 0$$

{here $\ln = \log_e$ }

Putting $x = 2$ & $y = 2$, we get

$$\Rightarrow 8(\ln 2 \cdot y' + 1) + 12(\ln 2 + y') = 0$$

$$\Rightarrow y' = -\left(\frac{3\ln 2 + 2}{2\ln 2 + 3} \right)$$

$$\Rightarrow y' = -\left(\frac{2 + \ln 8}{3 + \ln 4} \right)$$

$$125) \int \frac{x + \cos 2x + 1}{x \cos^2 x} dx = f(x) + K \log|x| + C \text{ and } f(\pi/4) = 1$$

$$\int \frac{x + 2\cos^2 x}{x \cos^2 x} dx = \int \frac{x}{x \cos^2 x} dx + \int \frac{2}{x} dx = \tan x + 2 \log |x| + C$$

$f(x) = \tan x$, $K = 2$ (by comparing)

$$\text{Now, } f(0) + 10K = \tan 0 + 10 \cdot 2 = 0 + 20 = 20$$

$$126) I_1 = \int_0^1 \cot^{-1}(1-x+x^2) dx = \int_0^1 \tan^{-1} \frac{x-(x-1)}{1+x(x-1)} dx$$

$$\begin{aligned}
&= \int_0^1 \tan^{-1} x \, dx - \int_0^1 \tan^{-1} (x-1) \, dx \\
&= \int_0^1 \tan^{-1} x \, dx - \int_0^1 \tan^{-1} (1-x-1) \, dx \\
&= \int_0^1 \tan^{-1} x \, dx + \int_0^1 \tan^{-1} x \, dx = 2 \int_0^1 \tan^{-1} x \, dx \\
&\Rightarrow I_1 = 2I_2 \quad \square \quad I_1/I_2 = 2
\end{aligned}$$

$$127) \frac{dy}{dx} = 2x(x+y)^3 - x(x+y) - 1$$

$$x+y=t$$

$$\frac{dt}{dx} - 1 = 2xt^3 - xt - 1$$

$$\frac{dt}{2t^3 - t} = x dx$$

$$\frac{2t^4 - t^2}{t dt} = x dx$$

$$\text{Let } t^2 = z$$

$$\int \frac{dz}{2(2z^2 - z)} = \int x dx$$

$$\int \frac{dz}{4z(z - \frac{1}{2})} = \int x dx$$

$$\ln \left| \frac{z - \frac{1}{2}}{z} \right| = x^2 + k$$

$$\ln \left| \frac{2z - 1}{2z} \right| = x^2 + K$$

$$\Rightarrow \ln \left| \frac{2(x+y)^2 - 1}{2(x+y)^2} \right| = x^2 + K$$

$$\text{Given } Y(0) = 1 \Rightarrow \ln \left| \frac{2-1}{2} \right| = 0 + K$$

$$\Rightarrow K = \ln \left(\frac{1}{2} \right)$$

$$\square \quad \ln \left| \frac{2(x+y)^2 - 1}{2(x+y)^2} \right| = x^2 + \ln \left(\frac{1}{2} \right)$$

$$\text{Put } x = \frac{1}{\sqrt{2}} \Rightarrow \ln \left| \frac{2(\frac{1}{\sqrt{2}} + y)^2 - 1}{2(\frac{1}{\sqrt{2}} + y)^2} \right| = \frac{1}{2} + \ln \left(\frac{1}{2} \right)$$

$$\Rightarrow \left(\frac{2(\frac{1}{\sqrt{2}} + y)^2 - 1}{2(\frac{1}{\sqrt{2}} + y)^2} \right) x^2 = e^{1/2} = \sqrt{e}$$

$$\Rightarrow \left(\frac{1}{2} + y \right)^2 - 1 = \sqrt{e} \left(\frac{1}{\sqrt{2}} + y \right)^2$$

$$\Rightarrow (2 - \sqrt{e}) \left(\frac{1}{\sqrt{2}} + y \right)^2 = 1$$

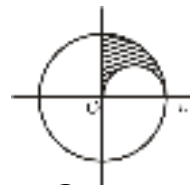
$$\Rightarrow \left(\frac{1}{\sqrt{2}} + y \right)^2 = \frac{1}{2 - \sqrt{e}}$$

$$z = \frac{1}{2 - \sqrt{e}}$$

Final Answer : Option (4)

128) Area the circle in 1st quad. = $\pi \cdot \frac{\pi^2}{4}$

Area of one loop of $\sin x = 2$



$$\frac{\pi^3}{4} - 2 = \frac{\pi^3 - 8}{4}$$

$$129) \frac{dy}{dx} = \frac{\left(\frac{dy}{dt} \right)}{\left(\frac{dx}{dt} \right)} = \frac{a \cos t}{a \left(-\sin t + \frac{1}{\sin t} \right)} = \tan t$$

$$= y \frac{\sqrt{1 + \left(\frac{dy}{dx} \right)^2}}{\left(\frac{dy}{dx} \right)}$$

length of the tangent

$$= a \sin t \frac{\sqrt{1 + \tan^2 t}}{\tan t} = a \sin t \left(\frac{\sec t}{\tan t} \right) = a$$

130) Apply LMVT in $x \in [1, 2] \quad -2 \leq \frac{f(2) - f(1)}{2 - 1} \leq 2$

$$\Rightarrow -2 \leq f(2) - 2 \leq 2$$

$$0 \leq f(2) \leq 4 \quad \dots(1)$$

Apply LMVT in $x \in [2, 4]$

$$-2 \leq \frac{f(4) - f(2)}{4 - 2} \leq 2$$

$$\Rightarrow -4 \leq 8 - f(2) \leq 4$$

$4 \leq f(2) \leq 12$ from (1) & (2) we get

$$f(2) = 4$$